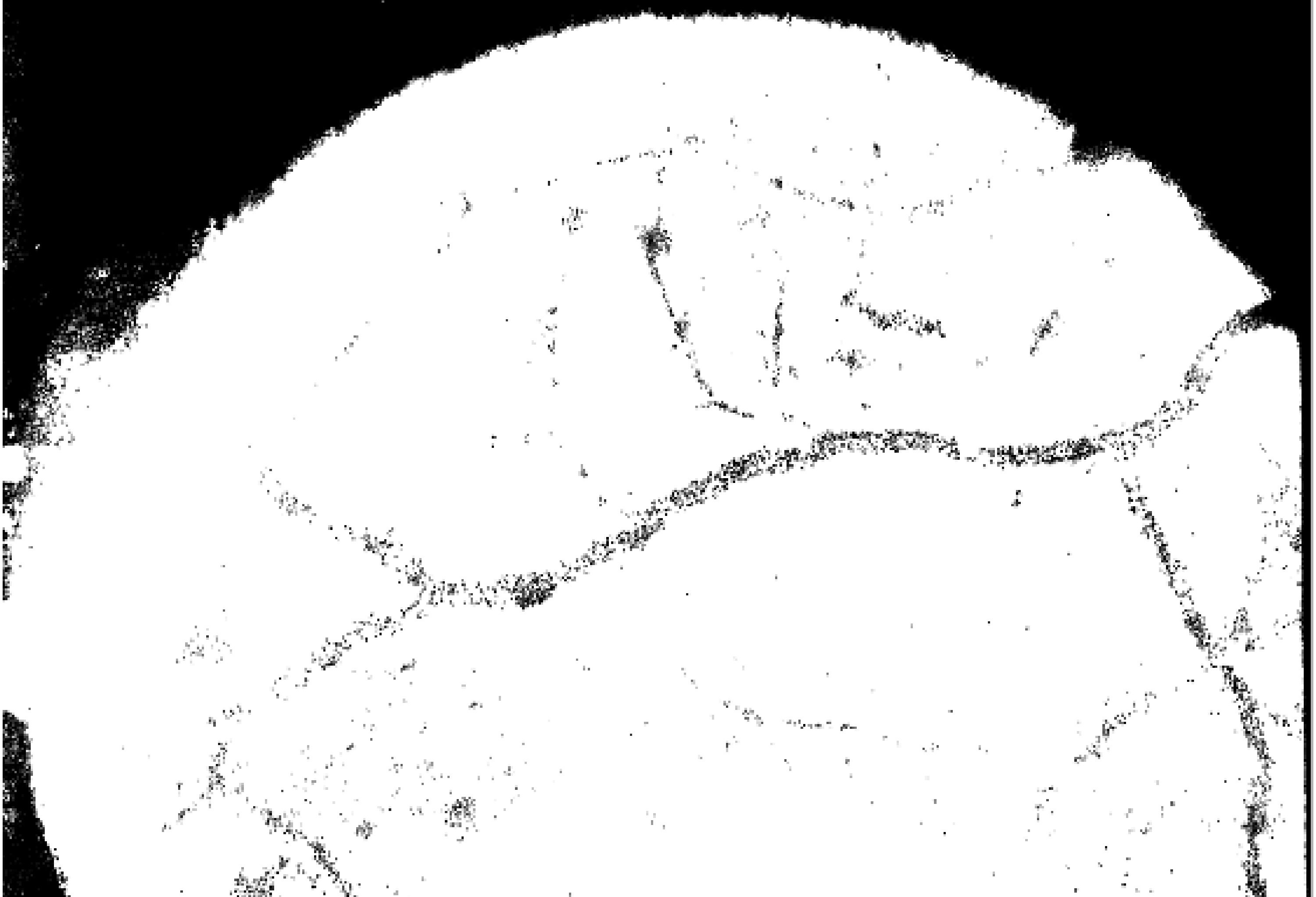
AUGUST 1980

# SCIENCE REPORTER



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## CONTENTS

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VOL. 17 AUGUST 1980 NO. 8

*Cover* Photograph showing retina of a patient with diabetic retinopathy (Transparency courtesy the author)

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496 LETTERS

498 PLANETS AND THEIR POSITIONS—SEPTEMBER 1980

MAIN ARTICLES

500 The DNA helix controversy — *Ehthesham Hasnain, Muzaffar Khan & Kailash Upadhyay*

504 Isomerism—a multiple identity in nature — *S. Satish*

510 How reproduction is controlled by hormones — *Chandrima Shaha*

516 Diabetes can cause blindness — *Bijayananda Patnaik*

522 The belligerent bats — *D. P. Jaroli & S. B. Lall*

526 SCIENCE SPECTRUM

Catastrophe theory—Atomic absorption spectrophotometry—Saponins—Saline alkali soils—Quarrying—a hazard to hill vegetation—Synthetic pyrethroids—Fevicol techniques in stomatal studies—The uropygial gland—The beautiful spider—Argiope

542 NEWS AND NOTES

India enters space age—C.P. Snow, a man of two cultures—Workshop on financial management in R & D

546 MEDICAL NOTES

Bacteria made to produce human interferon—Hepatotoxic effects of some chemicals and drugs—Valium (calmpose), the popular tranquilizer

548 SCIENCE FOR THE YOUNG

Time keeping of the world—Beautiful corals—Brain teasers—Science quiz

555 FOR HER

Ladies, beware of lady nicotine

557 SCIENCE IN INDUSTRY

External pace maker—Electronic tuners for TV receivers

558 TECHNOLOGY FOR VILLAGES

Mushroom cultivation—Central facility for safety evaluation of pesticides

490 BOOK REVIEWS

The Mighty Atom—Flora of Gujarat State—Science of Engineering Materials—The Study of Man—A Text Book of Modern Physics—Introductory chemistry

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## Solar eclipse

Sir, In the article **The total eclipse** (*S.R.*, April 1980), the information given was quite interesting and the photographs showing the eclipse from beginning to end were superb. However, the statement concerning the unusual behaviour of plants alongwith the path of totality so far remains a popular belief. The amateurs in general, and the botanists in particular, are interested to know 'how far plants were fooled by the false night at totality'? Those botanists who did some watchful research on that day may tell us how the plant parts reacted in response to the total eclipse. I trust this would interest a large number of *S. R.* readers.

T. ANANDA RAO
*Emeritus Scientist*
*Botanical Survey of India*
*Howrah-711103*

### II

The solar eclipse of 16th February, 1980 was vividly depicted by Biman Basu (**The total eclipse**, *S.R.*, April 1980). The author has correctly condemned the fear psychosis created by responsible persons, as a consequence of which millions were denied the unique opportunity of witnessing the spectacle of a lifetime. In this connection I would like to point an accusing finger towards distinguished members of the medical fraternity who, though motivated by the best of intentions, adopted an unwarranted cautious approach and strictly forbade viewing the sun in any manner. Even accepted norms of viewing the solar disc through filters, etc., were discarded outright. The result was disastrous and barren towns and cities presented an eerie sight—a grim indicator to our cowardice and pathetic concern for safety. Let us hope better counsel will prevail next time.

S. K. GURTU
*Defence Science Laboratory*
*Metcalfe House*
*Delhi-110051*

## Solar eclipse affects plants

Sir, In your **News & Notes** (*S.R.*, March 1980), it was interesting to read **Solar eclipse affects plants** by Prof. G. P. Mishra of University of Sagar, (M.P.). However, it is quite unfortunate that the experiments, as designed at the Indian Botanic Gardens, Calcutta did not aim at the best utilisation and intimate influence of solar energy by the green plants as to their unique process of photosynthesis. The vast array of products with various intermediates, on which practically all the living world is dependent, is manufactured by the green plants apart from their everyday task of purifying air with oxygen and assimilating carbon dioxide in presence of light. The major product starch being fairly widespread could have been experimented during the solar eclipse on 16-2-1980.

An additional observation on Indian 4 O'clock plant (Marvel), *Mirabilis jalapa* L. (*Nyctaginaceae*), locally known as "Krishko-koli" has been obtained. During February the plant starts blooming after 4 O'clock in the afternoon from the mature buds upto 6 p.m., i.e., it takes 2 hours for full bloom with profusion. But on the day of total solar eclipse all the mature buds completed their blooming and opened fully just before 4 p.m. starting rapidly at 3 p.m.

C. R. DAS
*Central National Herbarium*
*Botanical Survey of India*
*Howrah-711103*

## Eclipse and the eyes

Sir, Sh. Rajan (*S.R.*, May 1980) writes that the sudden emergence of a part of the disc of sun will injure the eyes of those who watch total eclipse. A large number of persons including myself watched the total eclipse at Puri for many seconds after totality ended and nothing happened to our eyes.

R. L. BRAHMACHARI
*Indian Statistical Institute*
*Calcutta-700035*

## Humour in science

Sir, B C Sharma in his interesting article **Humour in science** (*S.R.*, April 1980) has highlighted a very important and, at least in India, yet neglected field in science. I am inspired so much as to suggest you to have a regular feature incorporating cartoons and satire under the same title.

In this connection, I am also reminded of a beautiful acknowledgement for a Ph.D. thesis which runs like: "My thanks are due to Prof. X, B.Sc., M.Sc. Ph.D., etc. etc..., Head of the Dept., Chairman of...., without whose guidance I would have completed my work in half the time." And also some more quotable quotes: "If anything can go wrong, it will." "All experiments must be reproducible, they must fail in the same way."

S. K. NARANG
*Scientist*
*Corrosion & Coating*
*National Metallurgical Laboratory*
*Jamshedpur-831007*

## Growing ginkgo in plains

Sir, I read the article **Ginkgo—the living fossil** (*S.R.*, March 1980). It contains important and interesting information but there is a contradiction. The article informs that *Ginkgo* can withstand atmospheric pollution. The author suggests that in large cities of our country *Ginkgo* would be very helpful if planted in large numbers. He further states elsewhere that *Ginkgo* does not thrive in plains of India but does well at an elevation of 1500 m. It is difficult to understand how *Ginkgo* can be planted in cities like Bombay, Calcutta, Delhi, etc.

A. S. Sheikh
*Deptt. of Botany*
*Govt. P. G. College*
*Shajapur-465001*
*(M.P.)*

Although *Ginkgo* grows well at an elevation of 1500 m, it can also be grown in plains as well. Until now not many people have tried its cultivation in the plains. Besides, *Ginkgo* is a very hardy plant and can grow well under a wide variety of situations. There are specimens in the Missouri Botanical Garden in St. Louis, USA that have thrived under the violent contrast that that city can produce, temperature fluctuating from a minimum of 30°C in winter to 43.3°C in summer. There are also trees in the campus of the University of Massachusetts, Amherst, U.S.A., where the winter temperature is —32.2°C. In Dehra Dun, although its elevation is 610 m, the tree experiences violent fluctuating temperature ranging from 2°C to 40.8°C. But here the plants grow very well and perhaps the largest number of *Ginkgo* trees of our country, certainly more than a dozen, are located in Dehra Dun. I mentioned in my article that people should try *Ginkgo* in the plains too, and I am sure it will grow well if proper care is taken.

Md. S. Hoque
*Research Officer*
*Forest Genetics Branch*
*F.R.I., Dehra Dun-248006*

## Dal lake

Sir, Re: the interesting article **Is Dal lake dying**? by V. Kaul and A.K. Pandit (*S.R.*, Nov. 1979).

The authors have stated in the article that the lake is not polluted and is passing only through an initial stage of eutrophication. I do not agree with the authors and as per the data presented by themselves, I consider the Dal Lake as highly polluted. My reasons are given below:

1. The presence of low available phosphorus (17-37 μg/l) and high concentration of total phosphorus (214-450 μg/l) is an indication of the state of high eutrophication and pollution and not the initial stage of eutrophication in the lake, because where there are algal blooms, soluble reactive phosphorus (available phosphorus) gets incorporated in algae giving low available phosphorus but high total phosphorus;
2. The concentration of nitrate (115-450 μg/l) is not low but high indicating polluted condition;
3. Surface oxygen 11-15 mg/l and pH 7.2-8.5 indicates high eutrophic condition. In fact, authors should have given data on the sub-surface layers;
4. It is not correct to say that species of phytoplankton far exceeds zooplankton and therefore the lake cannot be said to be polluted at all. In fact, it is an indication of a polluted state;
5. The large number of migratory birds must be leaving behind enormous amounts of excreta into the lake adding to further enrichment; and
6. There is a lot of sewage from the surrounding areas and from large number of people living in boat houses which enters the lake daily.

For these reasons, I am not in agreement with the authors. The lake is highly polluted and eutrophicated.

G. P. Bhatnagar
*Section of Limnology*
*School of Biological Sciences*
*Bhopal University*
*Bhopal-462026*

## Book review

Sir, As the market is flooded with so many books dealing with various disciplines, sometimes by unknown or not-so-well-known authors, it is difficult for a student to find out which book will be an appropriate one and which one will serve his purpose. But your **Book reviews** feature has almost solved this problem. As five to seven books are reviewed on an average in each issue of *S.R.*, it is very easy to pick a right book for the discipline on studies. I refer to the **Book reviews** column for buying text-books at the start of a new semester. This bright feature has proved profitable to me.

Darshan S. Shah
*B.E. (Chemical) Sem. IV*
*Fatehpur, Paldi*
*Ahmedabad-380007*

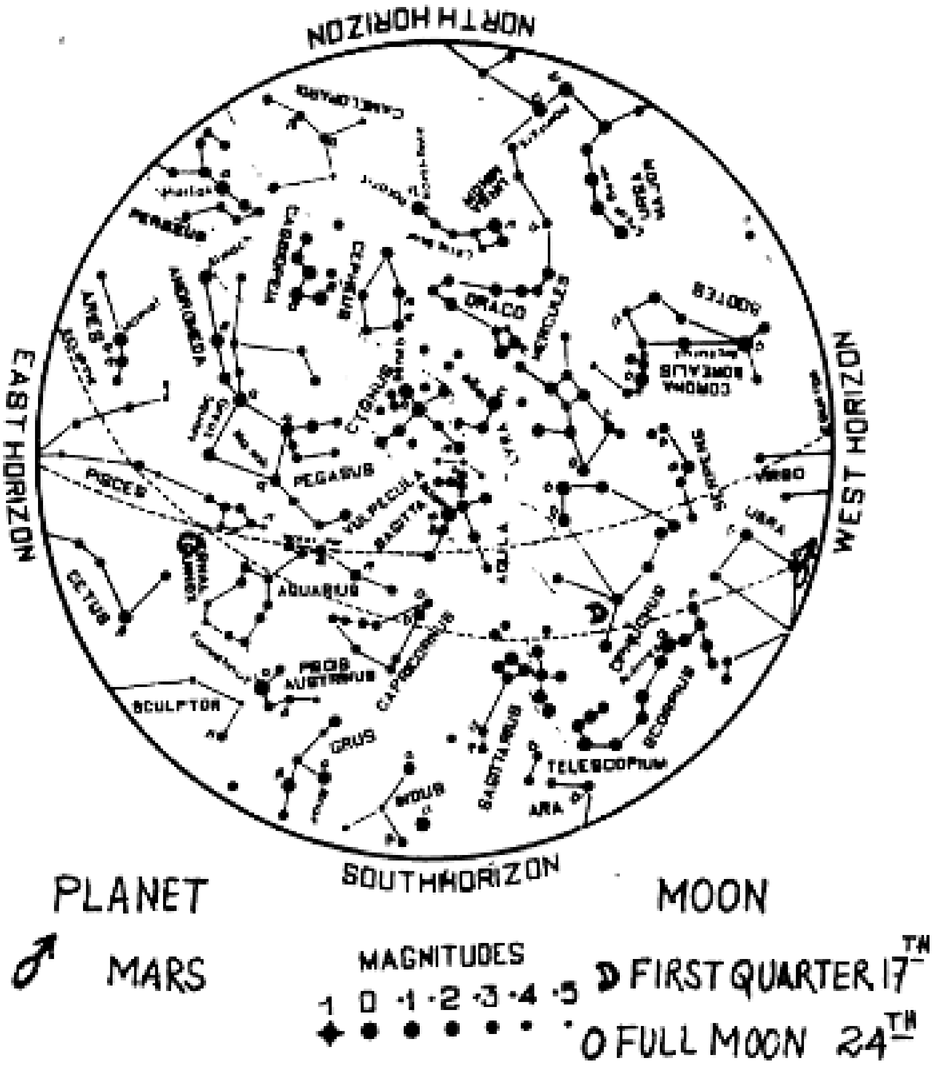
## Vitamin-D

Sir, I read the article, **Vitamin D—a vitamin or hormone?** by S. Ramakrishnan (*S.R.*, November 1979), with great interest. I am in agreement with the author's view regarding the physiological nature of vitamin-D. However, I would like to add that besides parathyroid hormone (PTH) and calcitonin, growth hormone (*Lancet*, i, 840, 1977), Ovarian sex steroids (*Fed. Proc.* 37, 926, 1978, *Endocrinology* **103**, 2035, 1978) and prolactin (*Nature*, **267**, 630, 1977) also modulate the activity of Vitamin-$D_3$ in order to meet the high calcium

(*Continued on page 562*)

# Planets and their positions

## September 1980



### The moon

NEW moon occurs on 9th at 3-30 p.m. and full moon on 24th at 5-38 p.m. I.S.T. The moon passes very close to Venus on 5th and about six degree north of Mars on 13th.

The lunar crescent becomes first visible after the new moon day in the evening of 10th.

The moon is at apogee or farthest from the earth on 12th and at perigee or nearest to it on 25th.

The sun is at the autumnal equinox on 23rd.

### The planets

**Mercury** (*Budha*) is too near the sun to be visible during the first half of the month. Thereafter, it reappears as an evening star and sets about an hour after sunset. It passes about one degree north of the star Spica (*Chitra*) on 25th. It moves from Leo (*Simha*) to Libra (*Tula*) through Virgo (*Kanya*). Its visual magnitude varies from −0.4 to 0.0.

**Venus** (*Sukra*), a morning star, rises about two hours after local midnight during the month. It passes about nine degrees south of thest ar Pollux (*Punarvasu*) on 2nd. It moves from Gemini (*Mithuna*) to Leo (*Simha*) through Cancer (*Karkata*). Its visual magnitude is about −3.8.

**Mars** (*Mangala*), visible in the evening sky, sets about two and a half hours after sunset during the month. It is in Libra (*Tula*). Its visual magnitude is +1.5.

**Jupiter** (*Brihaspati*) is too near the sun to be visible during the first three-quarters of the month. It is in conjuntion with the sun on 13th. Thereafter, it reappears in the morning sky and rises about an hour before sunrise. It moves from Leo (*Simha*) to Virgo (*Kanya*). Its visual magnitude is −1.2.

**Saturn** (*Sani*), visible in the evening sky, sets about an hour after sunset during the first quarter of the month. Thereafter, it is too near the sun to be visible. It is in conjunction with the sun on 23rd. It is in Virgo (*Kanya*). Its visual magnitude is about +1.2.

(*Source* : Director, Positional Astronomy Centre, India Meteorological Department, New Alipore, Calcutta-700 053)

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**The double helix model of Watson and Crick still continues to have an edge over other models**

# THE DNA HELIX CONTROVERSY

EHTESHAM HASNAIN MUZAFFAR KHAN KAILASH UPADHYAYA

A short communication to *Nature* (London) about 26 years ago brought scientific immortality to James Watson, a biologist and Francis Crick, a physicist. They had proposed a model (Fig. 1) known as the double helix (DH), for the structure of the most important and fascinating biopolymer, the DNA (*Nature*, 153, p 737, 1953). Judging from the scanty empirical evidence the proposal was in no way less than a prophecy. Year after year, the use of a variety of biophysical and biochemical tools has thrown up experimental data to only corroborate the double helix. Today, we find that most of the essential features of their model, viz., the double stranded nature, the two strands running anti-parallel, the sugar phosphate forming the backbone, the specific pairing of the bases (Watson-Crick pairing), the semi-conservative mode of replication etc., have already entered the realm of irrefutable facts X-ray diffraction pattern of the B-form of DNA, that was at their disposal, fitted well in their proposition that DNA is a helix produced as a result of the intertwining of the two strands around each other in a manner such that the helix makes a full turn of 360° after every ten base pairs. The other important feature of the model was the right handed nature (Fig. 2) of the constituent helices, i.e., when viewed from either end the two strands move away from the viewer in a clockwise manner—much like a person climbing up a spiral ladder, when viewed from the base will always be moving in a clockwise direction.

The major criticism against the double helix was the problem of unwinding of the two strands. For replication to occur, the two chains have to unwind in order to expose the bases (the ordered sequence of which carries the genetic information) to be copied to give a new complementary strand. This process which has to be very fast generates a torque in the DNA. So acute has been this problem that Max Delbruck suggested a modification of either the model or the process of replication it envisaged. Electron micrographs of heteroduplex and partially de-

---

Dr. Upadhyaya is Assistant Professor in the School of Life Sciences, J.N.U., New Delhi-110067: Shri Hasnain and Khan are research scholars in the same school natured DNA do not show any twisting in single stranded regions which should have normally been expected for the double helix, considering the significant winding or unwinding involved in the formation of these structures. There is yet another problem of packaging of the stiff rod-like Double Helix in viruses. It is very difficult to visualize how $33 \times 10^6$ dalton of DNA can be packed inside the head of a lambda virus having a volume of less than $16.1 \times 10^4$ nm$^3$. The elucidation of the structure of eukaryotic chromatin has created more difficulties for the Watson & Crick Model. DNA is chromatin is associated with histone (basic) and nonhistone (acidic) proteins. The association of histones with DNA produces a beads-on-string structures called nucleosomes. A nucleosome consists of 200 bp (base pair) of DNA, of which 140 bp of DNA is wound around four pairs of histones (two of each kind; $H_2a$, $H_2b$, $H_3$, and $H_4$) to form a nucleosome core particle and about 60 bp constitute a linker DNA (associated with H1 histone). In view of their small radius of curvature (30-50°A) the compression of Watson and Crick helix into the nucleosomes is rather too difficult to conceive.

## Alternative structure of DNA

In order to overcome some of the inherent problems of the DH, two groups of workers independently proposed alternative models of the molecular architecture of DNA. The models (Fig. 3) have not only attracted considerable attention but also generated much heat amongst the biologists and biophysicists. One group led by Sasisekharan, visualizes a side-by-side configuration (SBS model, or LR helix) with the two strands not wound plectonemically around each other but held side-by-side by Watson-Crick base pairing (*Curr. Sci.*, 45, p. 779, 1976). Thus, DNA is depicted as a non-intertwining structure (Fig. 4) involving right and left handed helical segments of five bp lengths, with the sugar residues in the alternating segments pointing in opposite directions. The change in handedness occurring after every 5 bp results in the formation of folds or bends in each strand. An interesting feature of this model is that when viewed from one angle it looks just like a double helix but after a rotation through 90° the two strands are seen apart. Rodley and coworkers from New Zealand also proposed an SBS model (*Proc. Nat. Acad. Sci.*, USA, 73, 2959, 1976) which is not a side-by-side model in the truest sense. As a matter of fact, it differs from the DH in that it takes one turn after about 100 base pairs as against 10 in DH. The problem of unwinding does, therefore, exist even in this model, although it is less acute. Sasisekharan *et al* have later shown (*Proc. Nat. Acad. Sci.*, USA, 75, p. 4092, 1978) on the basis of base-sugar stereochemistry and energetic considerations of base interactions that this type of model is not feasible. Further, a space filling model (a test of "fitness") of such a structure could not be constructed. We will therefore, concentrate on the LR model which continues to pose a serious challenge to the double helix.

## Evidences for the LR Model

The sugars in the polynucleotide have now been shown to have a puckered and not a planar structure, a fact which is difficult to accommodate in the DH. Watson and Crick model *ipso facto* meant a rigid rod-like shape of the DNA. The LR-

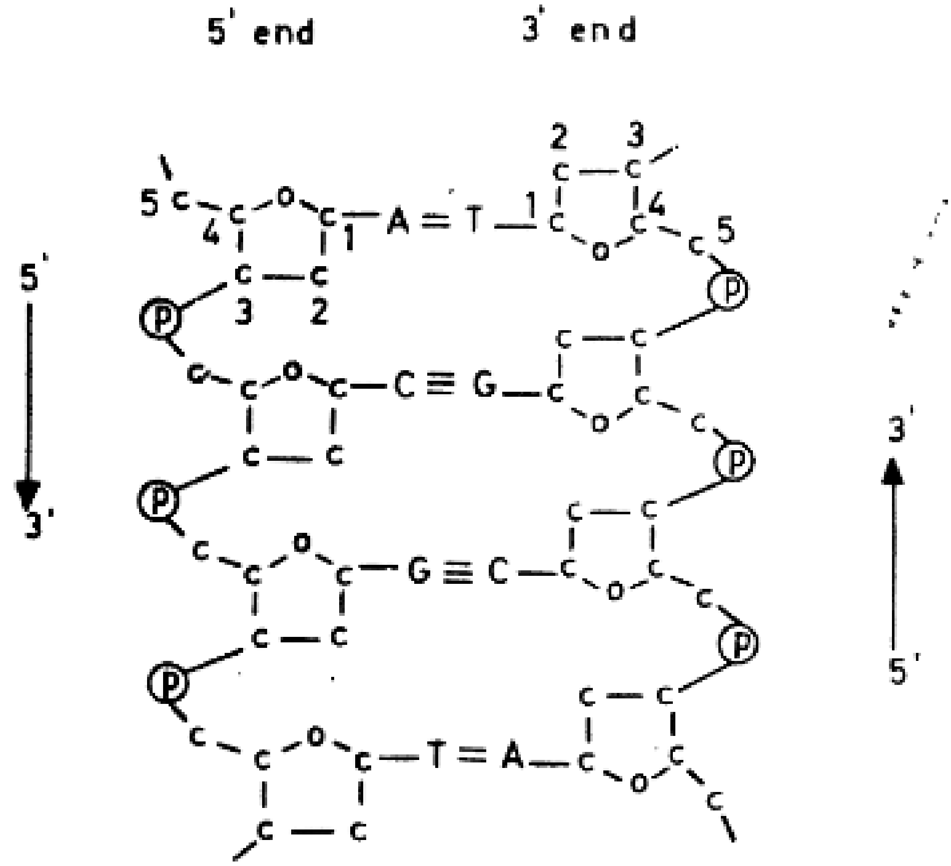

**Fig. 1. Watson and Crick structure of double stranded DNA.** The sugar phosphate forms the backbone of the helix while the bases are paired in the centre by the characteristic Watson and Crick pairing, i.e. adenine (A) pairs with thymine (T) and guanine (G) pairs with cytosine (C). The two helices have an opposite polarity, i.e., their 5' ends life in opposite directions

model, on the other hand, allows three distinct degrees of freedom, a property accorded to it on the basis of details of exact model building, stereochemistry and X-ray diffraction data. This bestows flexibility to the "rod like double helix" to the extent of eliminating any packaging problem. Since the stacking interactions at the bend remain almost the same, the LR model does not, as a corollary, demand coiling at the expense of increase in stacking or in backbone strain energy, thereby offering a mechanism of super coiling. Perhaps the most attractive feature of this model is the ease of unwinding of the two strands during replication. They can come apart by simple breakage of the H-bonds thus totally eliminating the energy expenditure in sliding and revolving of one strand with respect to the other. An explanation for the very fast initial rate of strand separation is therefore just not required.

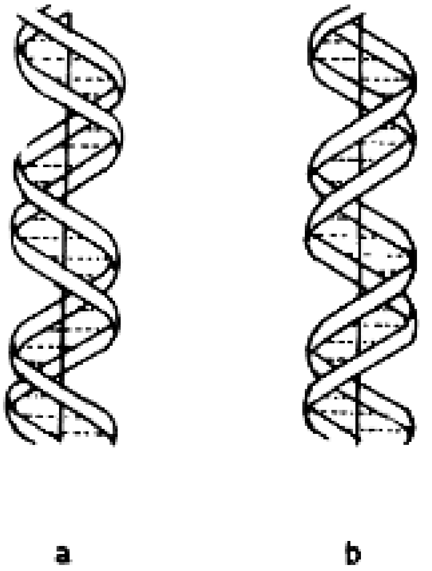

Fig. 2. Illustration of helix geometry showing a left handed double helix (b)

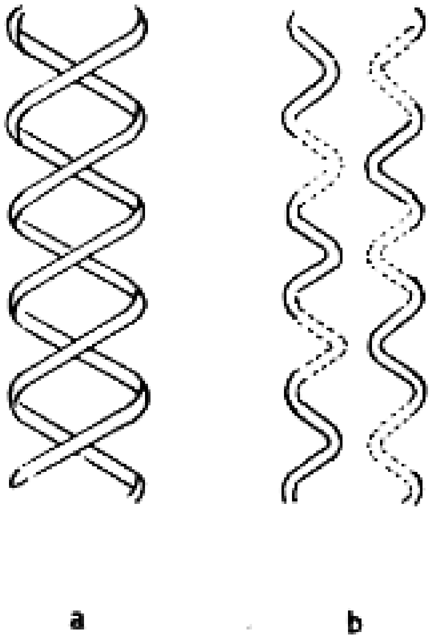

Fig. 3. A simplified view of a Watson and Crick Double Helix (a), and a side-by-side mode of Rodley *et al.* (b)

Crick and Klug (*Nature*, 255, p. 530, 1975) tried to explain the compression of DNA into nucleosomes by hypothesizing the existence of 'kinks' in the helix. These are the regions where the adjacent base pairs are completely unstacked and separated by unusually long distances (7A-8A). The flexibility, thus given to the DNA is virtually at the cost of continuity of the duplex. Turning to LR structure, the presence of folds formed by changes in handedness enables the DNA to trace a supercoil without the involvement of any steric strain, unfavourable base stacking, breakage of H-bonds or the continuity of DNA molecule.

In addition, there are some other evidences also. The characteristic "cross" features of the X-ray diffraction pattern of the B-DNA which was regarded as an evidence in support of DH, could also be produced by the LR structure. Probably the best direct evidence in support of the possibility of a left-handed helix comes from the report of the existence of Z-DNA. Rich and coworkers at MIT, USA (*Nature*, 282, p. 680, 1979) have worked out the molecular structure of a DNA fragment, and have conclusively demonstrated that this oligonucleotide is a left-handed helix having 12 residues per turn (of 10 residues in DH), the two chains running antiparallel and the ribose phosphate backbone following a zig-zag course (hence the name Z-DNA) resulting from conformation of alternating residues. The purines of this Z-DNA are in syn-conformation similar to what was recently proposed by Sasisekharan's group (*Curr. Sci.*, 49, p. 43, 1980). However, this Z-DNA is structurally different from both the Watson and Crick helix as well as the LR structure.

## In defence of the double helix

Francis Crick in his latest thought provoking defence of the DH (*J. Mol. Biol.*, 129, p. 449, 1979) points to some compelling observations, which leave one wondering about the validity of the LR structure. Effect of intercalating dyes readily explains the unwinding riddle whereas such interactions can be explained only on

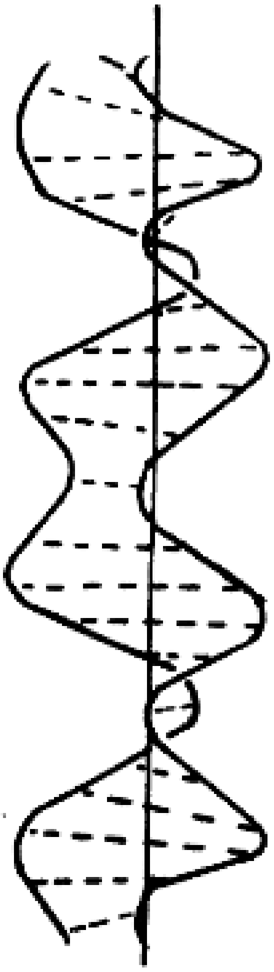

Fig. 4. The SBS.LR (Sasisekharan, *et al.*) structure for DNA showing lateral separation of the two strand (note that the two chains are not wound plectonemically)

assuming a stronger binding to the RH segments of the LR structure. The fact that DNA does unwind is further proved by numerous reports of the presence of DNA unwinding enzymes. Coming to the very existence of super helices, one can argue that such structures are the natural outcome of the helical intertwining character of the duplex, the explanation that the super helix is because of the helicity retained in the left and right-handed regions (LR model), appears to be unconvincing. If anything, the numerous reports of topoisomerases in viruses which relax only the twisted superhelical DNA without any energy requirement, are a proof of the fact that Nature has probably not overlooked the unwinding or packaging problem of the Watson and Crick helix. Assuming the LR model to be correct, what is the justification for the occurrence of enzymes like gyruses, helicases, topoisomersses etc.? Probably there is no apt answer. The right-handedness of the helix is supported by experimental evidences which are but suggestive in nature. The case in point is the observation that short RNA double helices in tRNA are right-handed. The binding of ethidium bromide to the helix reduces supercoiling by decreasing the local twist at the base pairs. This argument which is supported by model building and other general considerations, as well as by some direct X-ray diffraction studies can be true only on assuming that DNA is a right-handed helix.

The most penetrating evidence in support of DH stems from studies on the linking number (Lk) of circular duplex. Lk can be defined as the net number of times each chain of the helix coils around each other. By definition Lk is negative for LH and positive for RH helix. Taking an example, the Lk for a 5000 bp circular polynucleotide should be +500 in case of Double Helix, +50 for SBS structure (Rodley's) and zero for LR structure. Using two distinct classes of experiments—one depending on the uncoiling of a negatively supercoiled circular duplex and the other depending on detailed interpretations of the positions of gel electrophoresis band patterns produced by circular duplex—one arrives at the conclusion that Lk is equal to +500, that is to say, there are about 10 bp per turn of the helix. Estimation of Lk values for a viral DNA (PM 2) with 10,000 bp also gives a value (+1000) that is expected for a Watson and Crick helix. The evidence from gel electrophoresis pattern is rather too convincing to be dismissed as an artifact.

By far the simplest, though by no means less cogent evidence in support of double helix comes from denaturation studies of plasmid DNA. Thermal denaturation of a plasmid should, according to SBS model, result in the separation of two distinct intact, single-stranded circles (Fig. 5). However, such a thing has never been demonstrated. It is interesting to note here that a single nick in the plasmid DNA yields a single-stranded circular and a single-stranded linear molecule!

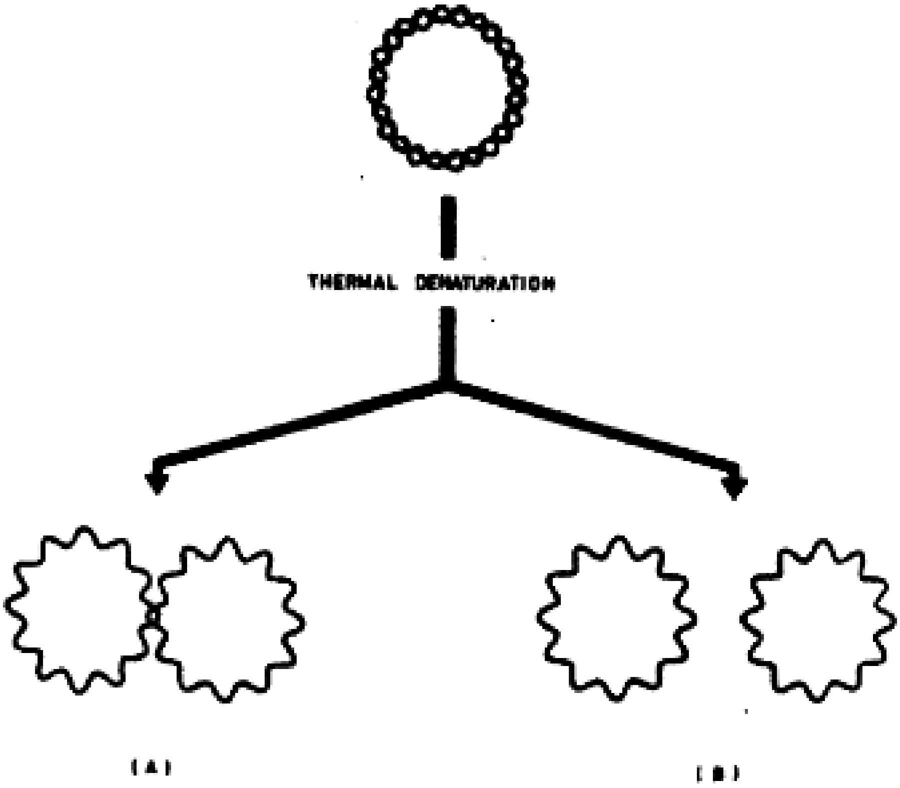

**Fig. 5. An idealized illustration of experiments showing the behaviour; after thermal denaturation; of a covalently closed circular plasmid DNA. (a) The two strands of the plasmid having a Watson and Crick structure; do not come apart but remain entangled; (b) A hypothetical situation of a DNA having SBS structure, yielding two separate single-stranded circles after denaturation**

## Conclusion

These considerations cannot but lead one to conclude that the double helix still continues to have an edge over the LR model. The LR model has at least, for the present, helped in establishing with a fair measure of accuracy, the basic features of the double-stranded DNA, as envisaged by Watson and Crick. In all fields of knowledge counter suggestions are of immense importance in the understanding and rectification of major or minor flaws in even firmly established concepts. To this end the SBS model has made a significant contribution. Even Crick does not rule out the possibility that under certain conditions

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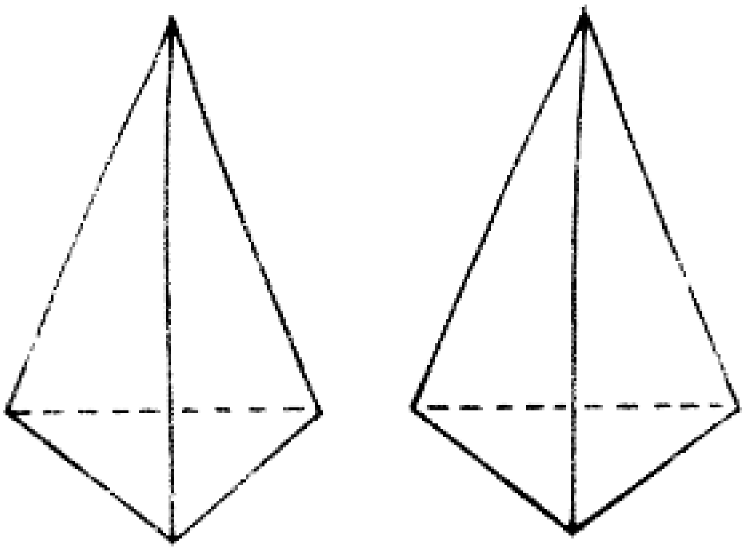
# ISOMERISM

S. SATISH



# a multiple identity in nature

**Isomeric chemical compounds are responsible for some of the most important functions in our life**

CHEMICAL molecules show varied properties and diverse end uses depending upon the arrangements of atoms in them. The behaviour of a molecule is determined not only by the number and nature of atoms comprising it but also on the way in which atoms are linked. Different spatial arrangements of atoms in similar molecules is termed as "Isomerism", a term coined by J. J. Berzelius in early nineteenth century. It is derived from a Greek word *isos* meaning "the same" and *meros* meaning "the parts".

The first historically known case of isomerism was that of silver cyanate ($AgC-N=O$) and silver fulminate ($Ag\ N=C-O$). It was discovered by two great chemists, L. Wohler working with J. J. Berzelius in Sweden and J. Liebig associated with J. Gay-Lussac in France. Liebig and Wohler independently isolated two chemical compounds of different properties but assigned the same chemical formula, $AgCNO$. Wohler brought this seemingly interesting observation to the attention of his mentor, Berzelius. They could recognise the then unknown property of the molecule and termed the phenomenon as isomerism.

At that time Berzelius could not have foreseen the wide occurrence of this phenomenon in chemistry, especially in organic chemistry. The most common example of isomerism can be represented by the chemical formula $C_2H_6O$. Depending upon the arrangement of carbon, hydrogen and oxygen, for example, it is possible to have two compounds of chemically different nature : Ethyl alcohol ($CH_3\ CH_2\ OH$) and dimethyl ether ($CH_3OCH_3$). This is a simple case of isomerism.

## Structural and positional isomers

In long chain carbon compounds (paraffins) there are three possible types of structural isomerism, viz., *normal*, *iso* and *neo*. These isomers differ in the branching and can be represented by the structures shown in Fig. 1.

Structural isomers of these types can be separated by taking advantage of the degree of their branching or cross-sectional diameter of the paraffins. Nowadays molecular sieves are commercially used for effecting such separations.

In aromatic compounds (organic compounds derived from benzene), if two or more groups are attached to a benzene ring, it is not sufficient to specify what the groups are but their relative positions should also be known. There are some common names for such positional isomers. For example, the three possible isomers of a disubstituted benzene are called *ortho*, *meta* and *para* as shown in Fig. 2. They are also known as 1:2, 1:3 and 1:4 isomers. Separation of such isomers can be done by the use of molecular sieves which is a process of commercial importance.

Positional isomers invariably have different physical and chemical properties (like melting point, boiling point and freezing point, etc., and reactivity) and they can be separated by taking advantage of these differences.

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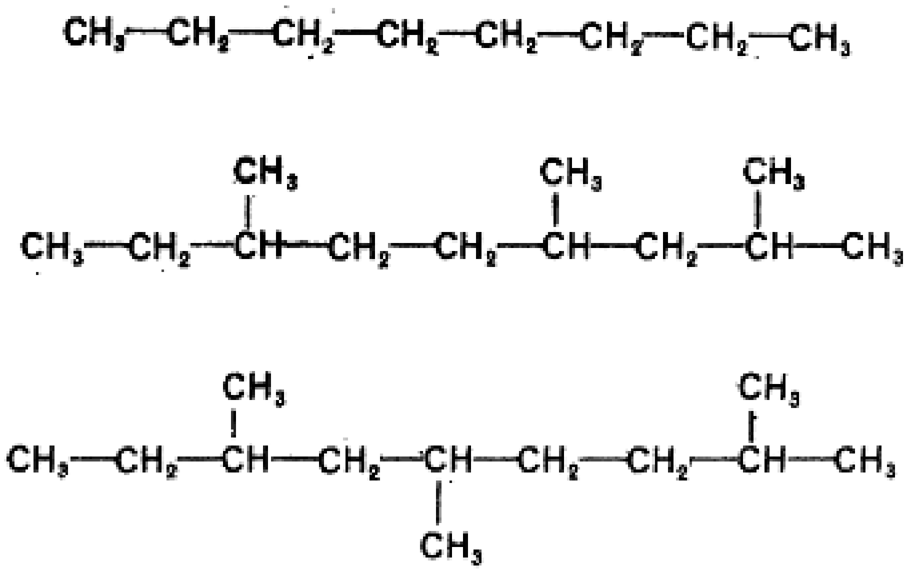


$CH_3-CH_2-CH_2-CH_2-CH_2-CH_2-CH_2-CH_3$

$CH_3-CH_2-\underset{}{\overset{CH_3}{\overset{|}{C}}H}-CH_2-CH_2-\overset{CH_3}{\overset{|}{C}}H-CH_2-\overset{CH_3}{\overset{|}{C}}H-CH_3$

$CH_3-CH_2-\overset{CH_3}{\overset{|}{C}}H-CH_2-\underset{CH_3}{\underset{|}{C}}H-CH_2-CH_2-\overset{CH_3}{\overset{|}{C}}H-CH_3$

**Fig. 1. Three isomers of paraffins. Normal-paraffin** *(Top)* **Iso-paraffin** *(Middle)*, **Neo-paraffin** *(Bottom)*

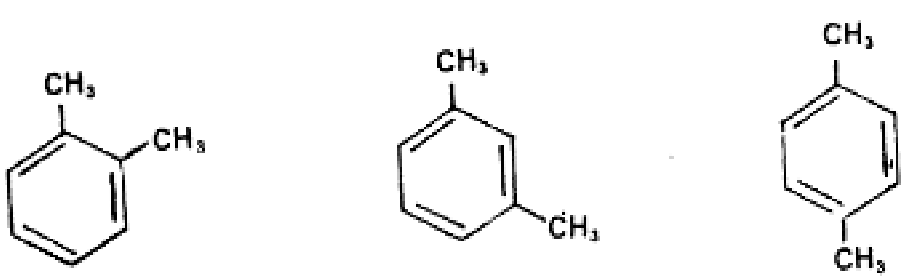


**Fig. 2. Isomers of xylene; ortho xylene** *(Left)*, **Meta xylene** *(Middle)* **Para xylene** *(Right)*

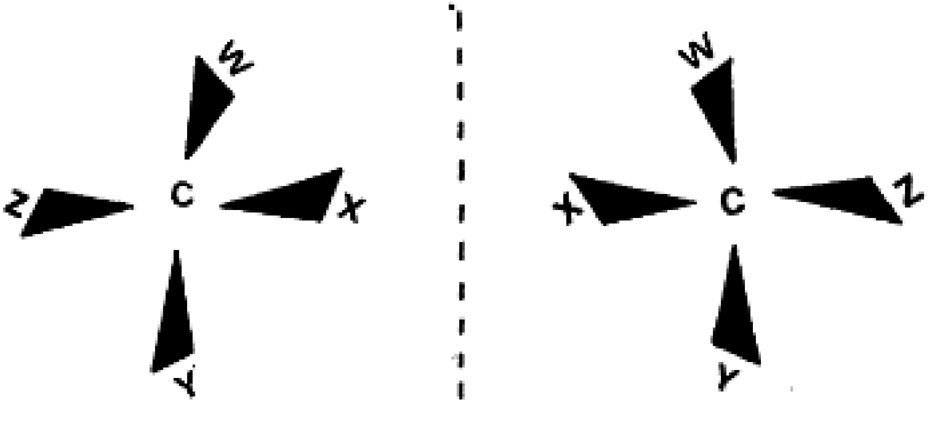


**Fig. 3. Nonsuperimposable mirror image of compound CWXYZ**

Structural and political isomers are not the only type found in nature. There are others like optical and geometrical isomers.

**Optical isomers**

Chemical molecules are three-dimensional entities in which atoms point to different directions in space. The same molecule can therefore have different spatial arrangement of atoms resulting in different configurations. These configurations are also isomers, but of a much subtle kind and are called optical isomers. Such isomers have similar physical properties (melting point, boiling point, density etc.) but exhibit different behaviour towards polarized light. Specialized techniques are therefore required to resolve or separate a mixture of optical isomers.

Optical isomerism is observed in compounds which possess what chemists call "asymmetric carbon atoms". Such molecules give rise to nonsuperimposable mirror images (Fig. 3). A molecule which contains just one asymmetric carbon atom (defined as carbon atom attached to four different groups) is always nonsuperimposable on its mirror image as shown in Fig. 3, and is always optically active. An optically active compound however need not always be asymmetric but it should be disymmetric. Such molecules are referred as chiral molecules.

One of the oldest known example of an optically active compound with a single asymmetric carbon atom is lactic acid $CH_3{}^*CHOH\ COOH$ (Fig.4) in which the starred carbon atom is asymmetric. It has long been known that lactic acid produced in living muscles (sarcolactic acid) is dextrorotatry or form (rotates the plane of polarized light to the right) whereas, part of the lactic acid formed by fermentation of lactose in milk (fermented lactic acid) is laevo-rotatry or l form (rotates the plane of the polarized light to the left). Synthetic lactic acid is a mixture of equal amounts of d and l (called racemic) and does not rotate the plane of polarized light. In nature asymmetric compounds are always present but asymmetric structures created in the laboratory are always a 50 : 50 mixture of both isomers. Current practice is to use (+) for d and (−) for l to distinguish between optical isomers.

Optical activity plays a very important role in the determination of specific property of a compound. Some of the interesting examples of stereostructure and property of organic molecules are shown in Table 1.

Nature's stereocontrolled synthesis of natural products like alkaloids, carbohydrates and terpenes, etc., can be

### Table 1. Stereostructure and fragrance property of organic compounds

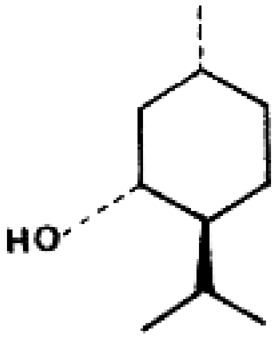
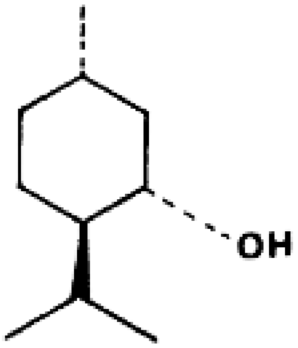
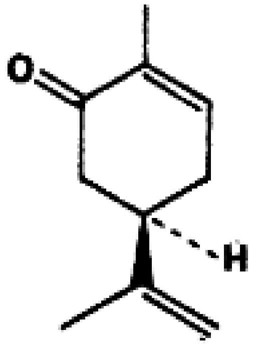
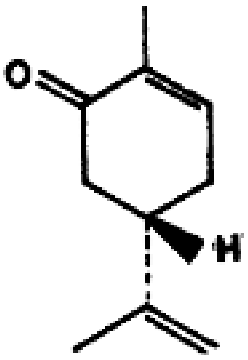
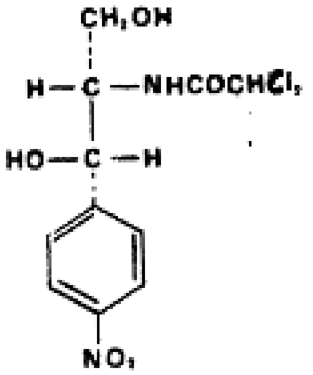
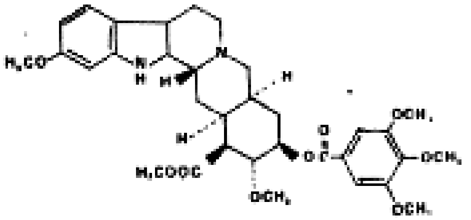
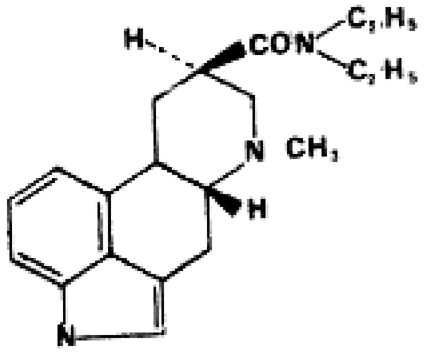
| *Name of the Compound* | *Structure of isomer* | *Specific property* |
|---|---|---|
| (−) Menthol | <br>(A) | Synthetic or natural is widely used in perfumes and flavours. Its main use is as fortifier for peppermint flavour with a cooling effect. |
| (+) Menthol | <br>(B) | Unpleasant flavour and of cooling effect. |
| Menthol | A+B | Used as a cheaper substitute of (—) Menthol. |
| (−) Carvone |  | It is a powerful spearmint oil substitute in chewing gums, tooth pastes, etc. |
| (+) Carvone |  | It is occasionally used. |

**Table 2. Stereostructure and biological activity of drugs**

| *Name of the compound* | *Structure of isomer* | *Biological activity* |
|---|---|---|
| (—) Threo chloramphenicol |  | It is the only dependable medication for typhoid fever and other susceptible bacterial meningitides. |
| Reserpine |  | Drug of choice for the treatment of hypertension and has also been used for the treatment of anxiety, tension, isomnia |
| (+) Lysergic acid —N, N-diethylamide |  | It has the remarkable psychedelic properties. |

studied *in vivo* by feeding radio labelled pure isomers to the plants. It can be shown unambiguously that only one isomer, which is a true precursor is incorporated to the maximum in the desired compound.

The specific activity of various drugs is also due to their stereochemistry, which in turn defines the most approxipriate configuration of a drug

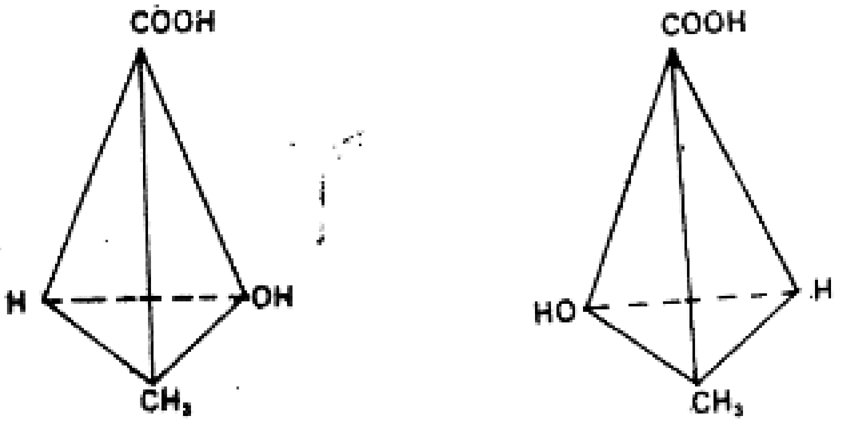
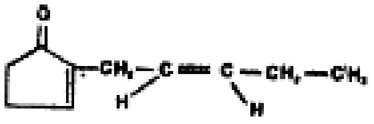
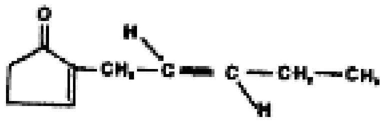
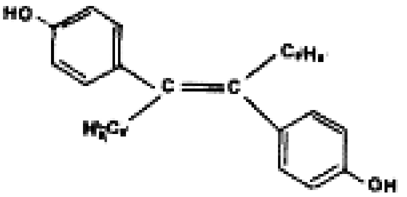


**Fig. 4. Molecular models of optically active lactic acid; (+) Lactic acid (*Left*); (—) Lactic acid (*Right*)**

Table 3. Effect of geometrical isomers on the property of organic molecules

| *Name of the compound* | *Structure of isomer* | *Specific property* |
|---|---|---|
| Cis-Jasmone |  | It is an important component of fine jasmin bases and used in numerous floral and nonfloral fragrances. |
| Trans Jasmone |  | Less floral fragrance |
| Trans Diethylstilbestrol |  | Nonsteroidal estrogen which stimulates the female secondary sex. |

receptor. Some representative examples of biological activity and stereochemical relationship are shown in Table 2.

Life as we understand is asymmetrically structured. The enzymes that control the life processes consist almost invariably of L (S) optically active amino acids. The nucleic acid dexoyribonucleic acid (DNA) which controls the genetic processes and ribonucleic acid (RNA) which functions in the synthesis of proteins are made up of D (R) optically active sugar residues. Here L(S) amino acids signifies that its absolute configuration is derived from L-serine amino acid and (S) shows the configuration at asymmetric carbon centre as per sequence rule is sinister (left handedness). D (R) sugars are related to absolute configuration of D-glyceraldehyde and (R) exhibits the configuration at asymmetrical carbon atom as Rectus (right handedness) according to sequence rule. These compounds are highly stereospecific as they are involved in controlling the vital stereochemical transformations at cellular level.

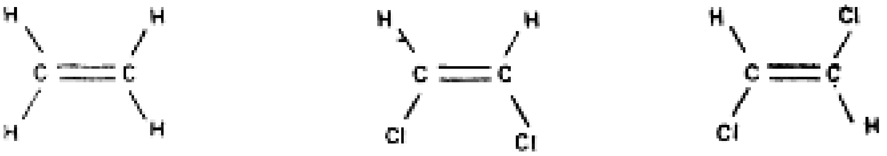


Fig. 5. Cis and Trans isomerism in double bonds; Ethylene (*Left*) Cis, 2-Dichloro-ethylene (*Middle*); Trans-1, 2-Dichloro ethylene (*Right*)

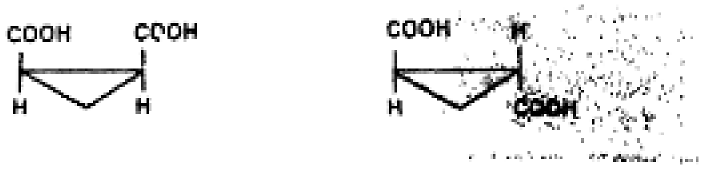


Fig. 6. Cis and Trans isomerism in carbo cyclic systems; Cis-1, 2-cyclopropane dicarboxylic acid (*Left*). Trans-1, 2-cyclo-propane dicarboxlic acid (*Right*)

## Geometrical isomers

Geometrical isemerism is observed in the compounds which possess a C–C double bond as in ethylene (Fig. 5). When the two other groups (Cl in this case) are on the same side of the double bond the isomer is termed as *Cis*, when they are located on opposite sides the isomer is *trans*. *Cis* and *trans* isomerism can also be visualised in disubstituted carbocyclic systems as shown in Fig. 6.

Geometrical isomers also occur in natural organic compounds. They

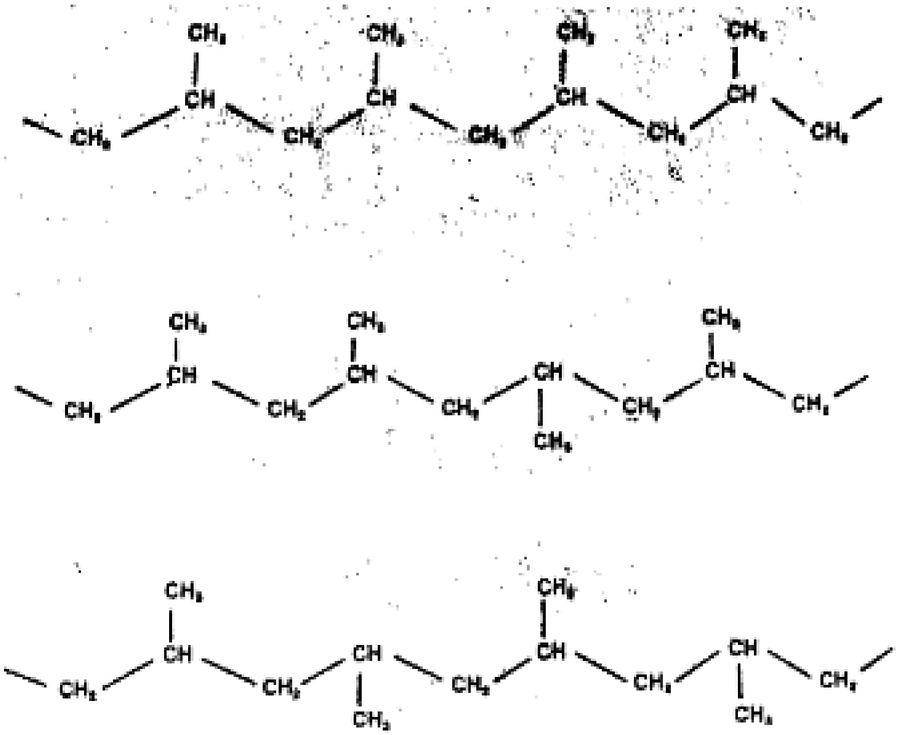


Fig. 7 Tacticity in polypropylene; Isotactic polypropylene (*Top*), Atatic polypropylene (*Middle*) Syndiotactic polypropylene (*Bottom*)

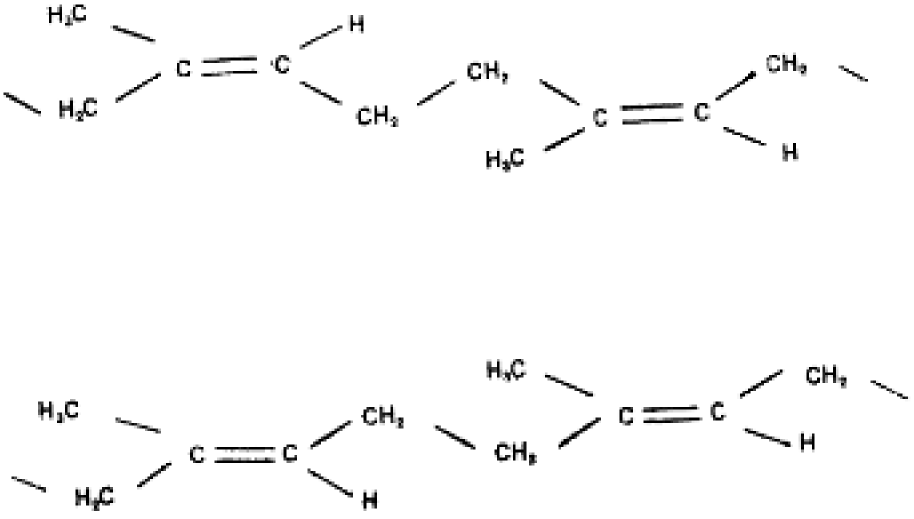


Fig. 8. Cis and Trans polyisoprene, Natural rubber (Cis-poly-Isoprene) (*Top*) Guttapercha (Trans-polyisoprene) (*Bottom*)

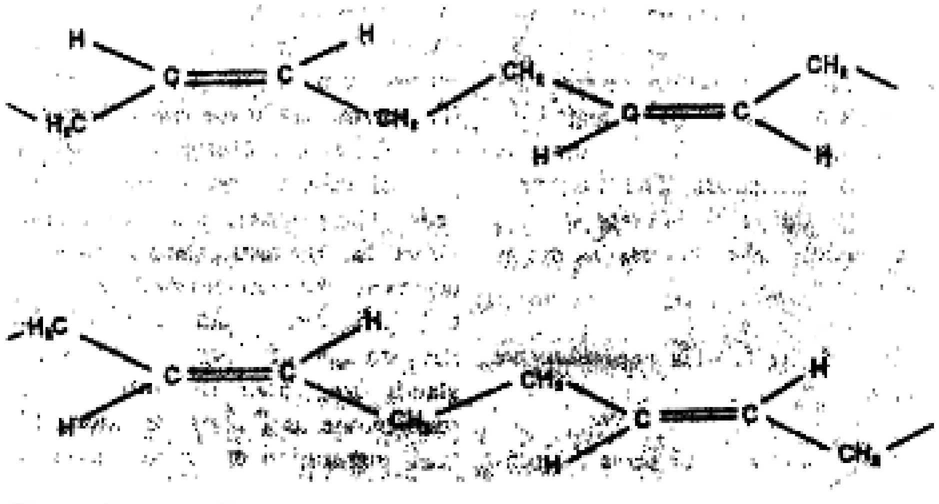


Fig. 9. Cis and Transpolybutadiene; Synthetic rubber (Cis-polybutadiene) (*Top*) Guttapercha (Trans-polybutadiene) (*Bottom*)

exhibit marked difference in their properties which can selectively be used. Some such examples of varying property of geometrical isomers are shown in Table 3.

## Isomerism in polymers

Unlike small molecules, the effect of isomerism in polymers are much more pronounced. It gives rise to major differences in the nature of isomeric polymers. Chemists and engineers have exploited these differences to the full advantage as is described below.

Propylene, for example, can polymerise to produce a polymer of three different types (Fig. 7) depending upon the technique used for polymerisation. Isotactic polypropylene (Karl Ziegler and Giulio Natta, 1953) has all the methyl groups on one side of the extended carbon chain. atactic polypropylene has methyl groups in random distribution, whereas, in syndiotactic polypropylene the methyl groups are alternately arranged. The regular arrangement of methyl groups, such as in isotactic, leads to a rigid plastic material which can be moulded into articles or blown into films. The irregular arrangement of methyl groups as in atactic results in a less useful, rubbery material.

Natural rubber is the *cis* polymer of isoprene (Fig. 8), which is a very useful material. The trans polymer of isoprene is a hard brittle material called Guttapercha.

Polymerization of 1,3-butadiene leads to a polymer with double bonds, which can have either of two alternative arrangements of groups as shown in Fig.9. Of this high *cis*-polybutadiene is a useful rubber and finds wide applications parallel to natural rubber. The trans isomer is hard and brittle and of little use.

Isomeric chemical compounds, be it polymers, biopolymers or small organic molecules, are responsible for some of the most interesting and important functions in and around our life. At present scientists are

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**From fertilization to parturition and birth, the various stages in pregnancy are controlled by a number of hormones**

THE process of sexual reproduction involves both the male and female organism in which father contributes the male gamete or the 'sperm' and mother donates the female gamete also called the 'egg' or 'ovum'. The union of egg and sperm (fertilization) froms a fertilized ovum from which the organism eventually develops by repeated divisions and redivisions. In most mammals, the embryo is nourished inside the mother's womb and when the term is over it is expelled to the exterior, but is fed with the mother's milk upto a certain period. The mammary gland is a distinguishing feature of mammals, for they feed their young with milk secreted by such glands. The mammary gland is a part of the reproductive apparatus and lactation is the final phase of reproduction. Failure to lactate means failure to reproduce. In this article the complex interplay of hormones that control the fromation os gametes within the male or the female body, the nourishment and the growth of embryo within the mother's womb, its expulsion outside the body and control of secretion of milk from the mother is discussed. The hormonal interaction differs in different species, here mainly the human aspect is discussed

## Male and the female reproductive organs

Both the male and female reproductive systems are wholly dependent on hormones, in their absence growth and differentiation of these structures does not occur.

In males the chief reproductive organ is the testis which produces the sperms and the male sex hormone testosterone (androgen). The testis consists of numerous tubules in which the sperms are made and in between the tubules are located a specialised type of cells known as the 'Leydig cells.' These cells secrete testosterone. Other than the testis, the accessory sex organs are the seminal vesicle and prostate for secretion, and epididymis for the storage of sperms. All these glands are under the influence of testosterone and their secretion aids final maturation of sperms. Even in

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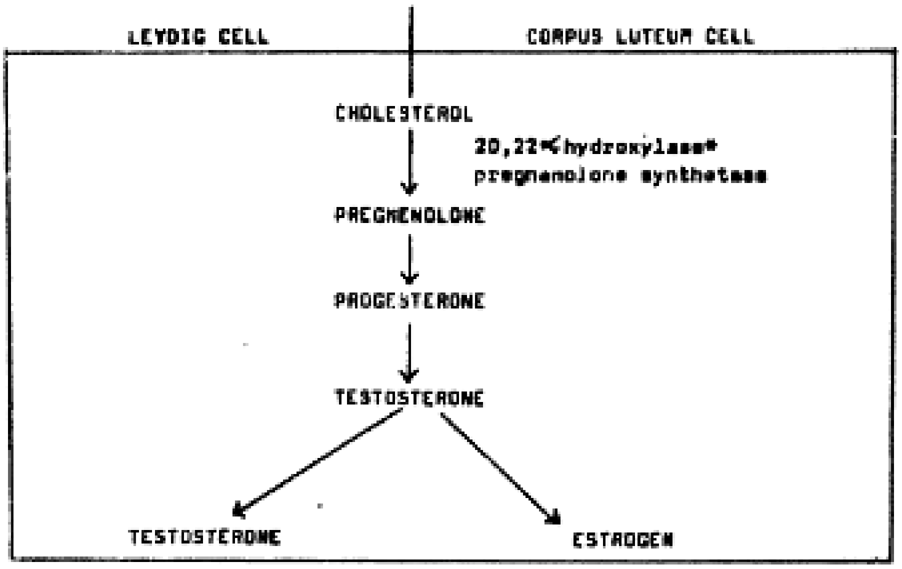
the epididymis some degree of maturation takes place.

Like the testis, the ovary is a compound organ with a dual function : production and release of the egg and formation of two hormones estrogen and progesterone. The ovary is composed of numerous follicles in which the maturation of the egg occurs. The fertilization of the egg takes place within the female body inside a structure known as the 'uterus'. It takes care of the fertilized egg and maturation and growth of the embryo takes place here. Apart from these two structures there are the mammary glands.

The follicles of the ovary with the developing egg secrete some amount of the two sex hormones but each time the egg is periodically shed (ovulation) the follicles form a structure known as the 'corpus luteum' which is the major source of the estrogen and progesterone

## Steroid production

The androgen, estrogen and progesterone belong to a group of compounds known as the 'steroids'. All steroids have a common basic structure —a cyclopentanophenanthrene nucleus with four rings, which has six carbon in the first ring and five in the last. The steroids are formed both in the testis and the ovary and the pathway of formation is same in both. The steps of formation are summarised in Fig 1



* LH acts by activating these two enzymes.

Fig. 1. Pathway of synthesis of steroid hormones

## The pituitary gland

At the base of the brain there is a small area known as the 'hypothalamus' from which a stalked organ is suspended. This tiny organ is known as the 'pituitary' and it is the ruler of most of the endocrine glands of the body. It can be divided into three parts; an anterior, median and a posterior part. The anterior part, also known as the adenohypophysis, secretes six hormones among which three control the function of the sex organs These three hormones together are known as the gonadotropnins and they are LH or lutenizing hormone, FSH or follicular stimulating hormone and Prolactin The production of sperms in the male is under the control of FSH and LH. Both of them act synergistically during and after puberty FSH is the more important hormone before sexual maturity is obtained and LH is necessary and has a dominant role after puberty FSH helps the growth of the tubules of the testis and LH activation is necessary for the production of male sex hormone Role of prolactin in case of male is not definitely known

In the ovary it is FSH which helps grow the follicles. After ovulation when the corpus luteum is formed LH acts on the cells of the structure and induces them to secrete more estrogen and progesterone. Both LH and FSH act synergistically before and after ovulation but FSH has the main role before and LH assuming a dominant role after ovulation. LH possibly acts on the leydig and luteal cell membranes in the male and female respectively by stimulating the adenyl cyclase enzyme located at the inner cell surface (*S.R.*, Jan 1978) by combining with the receptors for the specific hormones located at the cell surfaces This enzyme catalyzes the conversion of ATP to cyclic AMP, also known as the second messenger, which in turn activates a particular protein kinase to its activated form. This enzyme probably activates cholesterol 20, 22 α hydroxylase and also pregnanolone synthetase to act which converts cholesterol to pregnanolone (a substance produced in the pathway of steroid synthesis) It is also possible that LH triggers the release of a prostaglandin PGF$_2$ which is a smooth muscle stimulating lipid (Vide SR., Sept. 1979 responsible for the activation of adenyl cyclase.

The median part of the pituitary has no role in reproduction. The posterior pituitary, also known as the neurohypophysis, is composed of nervous elements which are connected to the hypothalamus It produces two hormones of which one known as the oxytocin has a dominant role in reproduction. It acts on the uterus and mammary glands

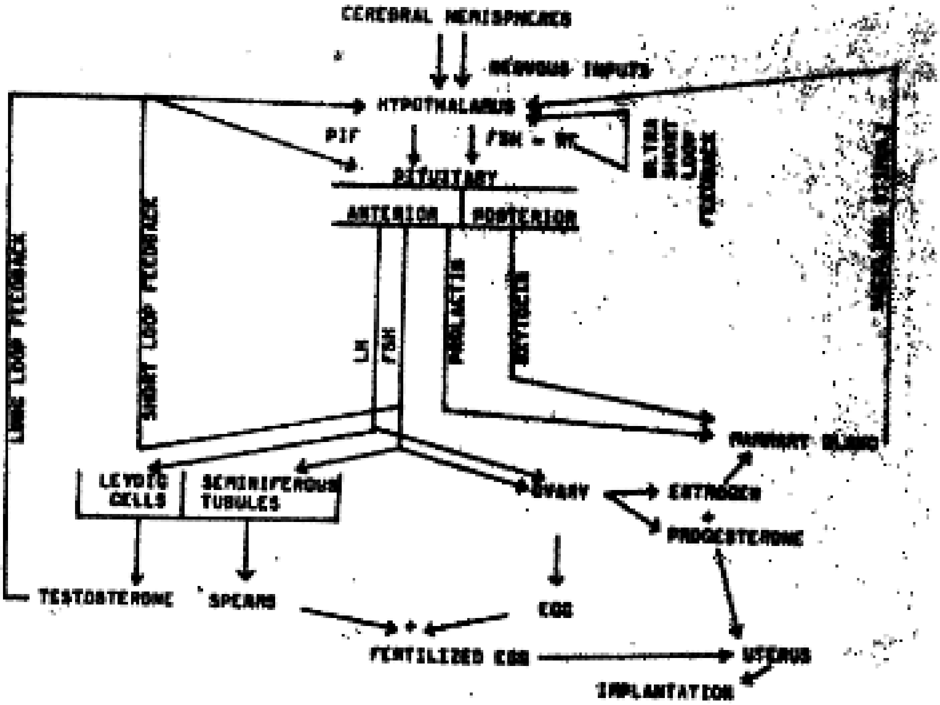


**Fig. 2. Relationship of hypothalamus pituitary and the reproductive organs represented diagrammatically**

## Control of FSH LH and prolactin secretion

The hypothalamus is the centre for controlling the secretion of gonadotrophins from the pituitary. It can be visualised as an enormously complex switchboard compressed into a very small space. An incredible number and variety of messages pour into it from different parts of the body and here they are received, decoded and decisions are quickly made which are sent in the form of instructions to the various parts of the body. The incoming and outgoing messages may be in the form of nervous impulses via nerves or chemical substances via the blood stream. The anterior pituitary is not connected with the hypothalamus by any nervous connection but a system of blood vessels connect the two. FSH releasing factor or FSH-RF, LH releasing factor or LH-RF and prolactin inhibiting factor or PIF are manufactured in specialised areas in the hypothalamus and are passed on to the anterior pituitary in response to messages received and they control the release of the specific hormones. All the releasing factors are believed to be small peptides (protein chains). FSH-RF and LH-RF are at present thought to be the same substance though there is some controversy regarding the fact.

## Feedback system of hormones

Each hormonal system has a built-in safety device by means of which the level of hormones in the body is controlled. This device is the 'feedback system' which may either be positive or negative. For example, negative feedback mechanisms occur when an excess of either steroidal or trophic hormone in blood prevents releasing factors to be secreted from the hypothalamus or hormones from the pituitary to be released. Positive feedback occurs when steroid or trophic hormones in blood causes a positive event. These negative and positive feedback systems may be of three types, the 'long loop', 'short loop' and the 'ultra short loop' feedback system. In the long loop feedback system the hormones which are secreted from the target glands, for example, testosterone from the testis under the influence of LH from the pituitary, may inhibit the secretion of LH by acting on the pituitary or on the hypothalamus thus inhibiting the release of LH or LH-RF. In a short loop feedback system the LH itself will act on the pituitary or hypothalamus. When releasing factors acting on the hypothalamus inhibit the secretion of the releasing factors themselves, it is known as the ultra short loop feedback system. All these systems operate when the level of hormones in the body becomes more or less than the normal level.

## Spermatogenesis

Spermatogenesis is the development of sperms occurring in the tubules of the testis. The development proceeds through several stages and each stage represents a particular type of cell. To name the stages one after another they are primordial gonocyte, spermatogonia, primary spermatocyte, secondary spermatocyte, spermatids and mature sperms in the epididymis. In the spermatid stage the development occurs through 19 stages. The interconversion from one stage to another requires different hormones. The conversion of primordial gonocyte to spermatogonia, primary to secondary spermatocyte, secondary spermatocyte to spermatid and spermatid to sperms need testosterone, while transformation of spermatids from stage 15 to 16 requires FSH. The conversion of spermatogonia to spermatocyte occurs without the aid of any hormone as has been found in the organ culture studies

## Role of sex hormones

Testosterone is responsible for the development of the male sex organs, growth of hair, deepening of voice and sexual desire which occurs in the male with the advent of puberty. In the female, the estrogens and the progesterone act on the female reproductive tract at different times of the sexual cycle and also help the development of breasts and other sexual characters. Progesterone is chiefly the hormone of pregnancy and it is essential for the initial establishment and continuation of gestation.

### Menstrual cycle

The menstrual cycle is a characteristic of the primates and it differs from the sexual cycle of other species as it is accompanied by heavy bleeding. The entire cycle can be divided into two phases, the pre-ovulatory and the post-ovulatory phase. There is a high level of FSH at the beginning of the pre-ovulatory phase when growth of the ovarian follicles takes place. The follicles start secreting estrogen and its level gradually rises until just before ovulation there is a sharp increase in its content which acts as a stimulus for a sudden rise in the concentration of LH. LH is responsible for the ejection of egg from the follicles. There is some controversy about the mechanism of the rupture of the follicles. According to one view, the LH causes more progesterone to be synthesised which induces the production of a collagenase-like enzyme that acts on the collagen of the follicular walls and renders them distensible which ultimately ruptures and frees the ovum. Immediately after ovulation the follicle forms a structure, the corpus luteum. This structure secretes large amount of estrogen and progesterone which prepares the uterine bed for the fertilized ovum. If the ovum is not fertilized, the corpus luteum degenerates after a certain period of time. This causes the endometrium (the wall of the uterus) to break owing to the fall of the steroid level. As the inhibiting action of the steroids on the pituitary is removed, there is an increase in the concentration of FSH and LH which prepare the follicles for the next cycle.

### Hormonal control of pregnancy

When the egg is fertilized a different train of events occur. The regulation of gestation comprises of a series of complex interactions between protein hormones that maintains the corpus luteum and steroid hormones directly concerned with maintainance of pregnancy (Fig. 3). The fertilised egg attaches itself to the wall of the uterus. This phenomenon of establishing physical contact with maternal organism is known as the 'implantation'. The embryonic issue specialised for interaction with the uterus of the mother is the 'trophoblast'. The implantation takes place only when the uterus is in a maximum sensitized condition by the steroid hormone actions. The fall of steroids does not occur if implantation takes place and the corpus luteum

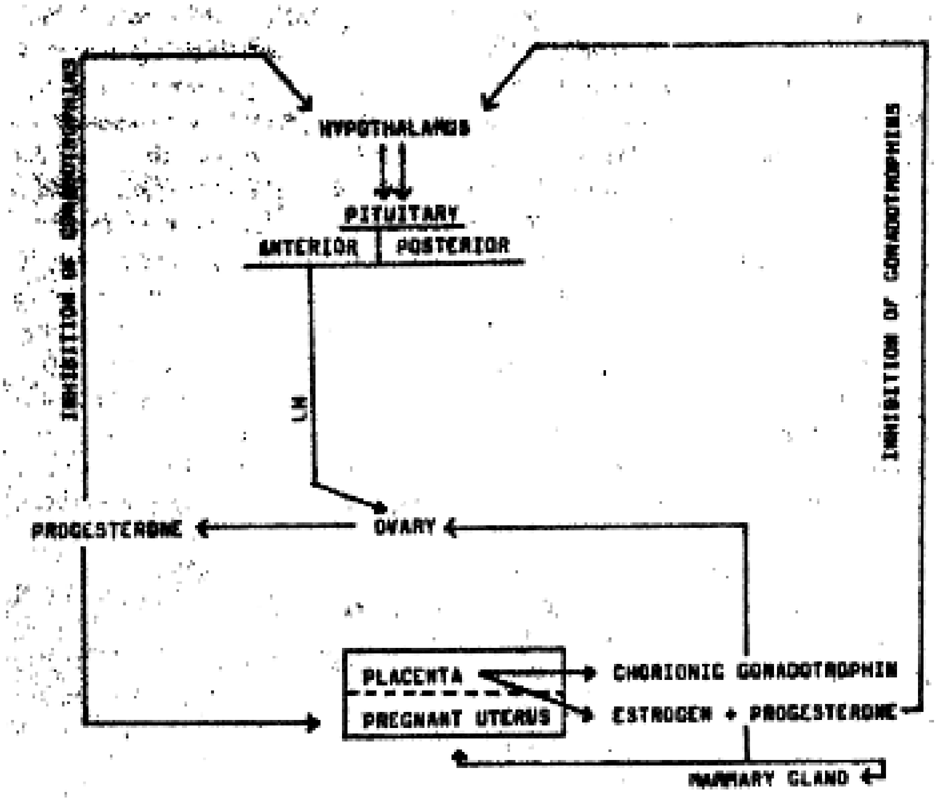


Fig. 3. Hormones and the maintenance of pregnancy

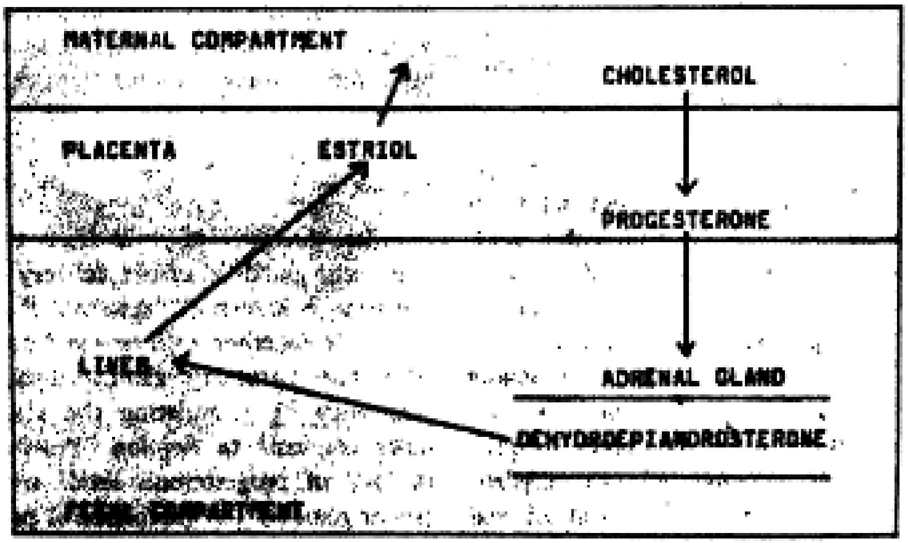


Fig. 4. Working of the feto-placental unit

continues to secrete estrogen and progesterone. In some species the corpus luteum secretion is maintained throughout pregnancy but in others, including the humans, mice and rabbit, etc., seteroid secretion is taken up by a specialised structure known as the 'placenta'. This organ holds the maternal and fetal tissue in close union and through this structure the mother gives nourishment to the fetus during gestation. The persistence of corpus luteum and thereby very high levels of steroids prevent the menstrual bleeding to occur. In case of primates the corpus luteum is maintained in early pregnancy by a hormone known as the 'chorionic gonadotrophin' which in humans is known as the 'human chorionic gonadotrophin' As the placenta grows and differentiates, it secretes more and more estrogen and progesterone and the secretion of chorionic gonadotrophin decreases as the function of the corpus luteum is taken over by the placenta and there is no further need to maintain the ovarian structure. The human placenta also produces a hormone, the 'human placental lactogen', which helps develop breasts and also possibly maintain the corpus luteum. The steroids aids the growth of uterus that takes place to accommodate the fetus and also the growth of the mammary glands.

The placenta is a fascinating organ as it is an endocrine gland in a small package. Together in it, it combines the biochemical properties of the ovary, pituitary and the corpus luteum. The fetus and the placenta are so closely associated that they are often termed as the 'feto-placental unit' (Fig. 4). Estriol, a placental estrogen, is secreted in large quantities during pregnancy but placenta alone cannot manufacture it. It probably converts cholesterol to pregnanolone and then to progesterone. progesterone is converted into dehydroepiandrosterone by the fetal adrenal gland, the fetal liver then adds one hydroxyl or OH group to this weak androgen which is then passed back to the placenta and there it is converted into estriol. Progesterone is the hormone of pregnancy and possibly its main role is to reduce the muscular contraction of the uterus and thereby preventing the expulsion of the fetus prematurely. This is known as the 'progesterone block'. There is some controversy regarding this theory. Placental estrogens like ovarian estrogens induce development of the mammary glands, uterine muscles during pregnancy and also the widespread changes that take place in the mother's body.

## Parturition

The mechanism involved in parturition is still not very clearly understood. The actual stimulus that initiates labour is not clear. Presumably there is a fall in steroid level just before parturition. Oxytocin, the posterior pituitary hormone which is secreted during parturition, speeds up and strengthens the contraction of the uterus and aids expulsion of the fetus. During this period there is a pelvic relaxation in which the pelvic bones become less rigid and the birth canal is enlarged thereby making the whole process easier. These pelvic modifications are brought about by a hormone called 'relaxin' which is present in the ovaries and the placenta. Relaxin mainly acts in conjunction with estrogen. Recently role of a prostaglandin in partutition has been predicted.

## Lactation

The secretion of milk from the mammary glands after the delivery of the fetus is known as 'lactation'. Progesterone together with estrogen prepares the mammary glands during pregnancy by stimulating the glandular elements to develop. Possibly the fall of progesterone level with labour removes any inhibition of prolactin secretion. Prolactin maintains the milk secretion but initiation of secretion is brought about by infant's suckling.The suckling causes a tactile sensation that sends afferent impulses to the hypothalamus which instructs the posterior pituitary to secrete oxytocin. This hormone travels via the blood stream to the mammary gland where it causes the contraction of particular type of cells and induces milk secretion.

## Other endocrine glands

Several endocrine glands play minor roles but they are not directly concerned with reproduction. Thyroid, pancreas, parathyroid and the adrenals take part in adjusting the differing conditions imposed by pregnancy.

The pineal gland is another endocrine organ which plays some role in reproduction. It is a small pine cone-shaped structure situated in the brain and secretes 'melatonin'. This substance inhibits gonadal function. Secretion of melatonin is increased in the dark while it is inhibited in light. It has been seen in laboratory animals that continuous exposure to light leads to gonadal weight and size increase indicating removal of inhibitory action of melatonin on them due to presence of light.

This is, in short, the control of reproduction by hormones which can be studied in a greater detail and at the same time is a growing subject in which new facts are coming to light frequently.

## Further reading

1. Austin C. R. and Short R. V., *Hormones in Reproduction, Book 3 of the series Reproduction in Mammals* Cambridge University Press. London. (1975)
2. Brotherton, J., *Sex Hormone Pharmacology*. Academic Press. London.
3. Tepperman, J., *Metabolic and Endocrine Physiology*, Year Book Medical Publishers Chicago. (1973).

WHAT HOLDS A COUNTRY TOGETHER ?

"Basically, the people's love for it and willingness to work and sacrifice for it.

"Of course, this is not entirely altruistic, for each person knows that his interest is intrinsically bound with his country's future"
—Indira Gandhi

on this
33rd
anniversary
of our
independence

Let us remember the immortal words
of C.R. Das
"Who Lives if India Dies ?"
WE HAVE ONLY ONE GOAL
to build a strong,
self confident, India

come, let us all work together

davp 80/127

# DIABETES CAN CAUSE BLINDNESS

BIJAYANANDA PATNAIK

**Diabetic retinopathy, if left untreated, can lead to blindness. At present photocoagulation provides the best and only meaningful treatment for it**

WHEN a person with diabetes lives for long years through good "control of diabetes", he or she, sooner or later develops changes in the retina—the highly sensitive layer of the eye which makes vision possible. This change is known by doctors as Diabetic Retinopathy (D.R.). D.R. progressively and relentlessly reduces vision which ultimately results in gross visual loss or total blindness. The quality of diabetic control does not seem to improve the downhill course of D.R. The condition was unknown 50 years back, when most diabetic patients used to die before the diabetic retinopathy could cause blindness. However, today by regular injections of insulin diabetic patients can be helped to live to ripe old age. Unfortunately, supplementing insulin does not seem to solve all problems for the diabetics; the most disturbing of these unsolved problems being D.R. With the increasing longevity of the diabetic patients through modern medical care, the number of diabetics going blind due to D.R. is increasing rapidly. As a result D.R. has become one of the most important causes of blindness in the western countries. The problem is slowly assuming disturbing proportion in India too. It is so specially among the urban population of well-to-do families. With our public hospitals running effective diabetic clinics the problem will sooner or later appear among all sections of the population.

In diabetic patients, the shortage of insulin results in all round slowdown in the storage, supply and utilisation of most important energy providing fuel : glucose. The tissue cells cannot get glucose through their walls, what gets through cannot get metabolised to provide energy. As a result any additional supply of glucose through food results in accumulation in the blood, causing high blood sugar (glucose) levels. Like overflow pipes in storage tanks, meant to drain out the excess of water, the kidneys start draining glucose through urine (sugar in the urine) when blood glucose level rises above 180 mg per 100 milliliter of blood. Very high blood sugar level can cause unconsciousness known as diabetic coma (Hyperglycemic coma) or even death.

The liver, the central storehouse for glucose, not being in a position to store glucose without the help of insulin, cannot release supply during lean periods, as when one is hungry and without food. The drastic fall of blood sugar level results. All tissues of the body suffer. The brain which depends exclusively on glucose for energy suffers the most. Insulin is also needed to convert fat or protein into glucose (as in a state of starvation). In the absence of insulin even alternate sources for energy are denied to the body for use. Too low a blood sugar can cause coma (Hypoglycaemic coma) or death.

Since vitality of body tissues depends on their capacity to utilise energy, in the state of insulin shortage the body becomes prone to infection. The diabetic patient unable to fight infection through proper use of energy often falls a victim to it. That explains why tuberculosis is so common among diabetics.

The modern treatment of diabetes aims at : (i) supplying insulin by injections, (ii) coaxing the Beta cells (the cells which produce insulin in the body) to produce more insulin, or (iii) preserving the insulin from natural destruction. Through one or more of these measures the effective amount of insulin available for utilization of glucose can be raised to appropriate level so that the cells take up glucose in sufficient quantity for storage or utilisation. As a result blood glucose levels fall to normal and glucose no longer leaks through the kidneys—urine becomes free from sugar. The case is said to be under control.

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Since D.R. develops whether or not diabetes is kept under control, it is clear that the abnormalities in diabetes are not confined to insulin shortage alone. What those abnormalities are, we do not know. What we do know is that the longer a diabetic patient lives, the higher are the chances of his developing retinopathy. For instance, it has been estimated that if, say, 100 patients of diabetes are kept under watch for signs of D.R., 90 will develop retinopathy after 18 years and all will develop the disease in 25 years. Diabetes occurs more in females than males in the ratio of 3 : 2. They are also prone to develop retinopathy (ratio 4 : 3). Therefore, till the exact cause of diabetic retinopathy is known —so that the process can be prevented or even reversed (which unfortunately, remains a distant dream) —the only alternative left is to try to ensure useful vision for as long as possible, preferably as along as the person lives.

### What happens to the retina in diabetes

Diabetic retinopathy is an expression to describe a series of dangerous changes in the retina which ultimately lead to gross visual loss or total permanent blindness. The earliest and the most fundamental changes take place in the finest blood vessels—the capillaries of the retina. Because of weakness developing in the tubular walls of these blood vessels small outpouchings develop—known as micro aneurysms (Fig. 2). Through these weakened walls blood and serum leak out causing small retinal haemorrhages (bleedings) and white exudates (Fig. 1). The retina becomes oedematous (swollen). Over small areas the capillaries close down — getting occluded (Fig. 3). As a result, the retina, deprived of normal oxygen, stimulate the growth of new blood vessels (Fig. 4), presumably through the release of a vaso-formative substances —nature's attempt to compensate for the lack of oxygen.

Fig. 1

The retina, like brain, is protected from many toxic substances in the circulating blood by special arrangement of cells in the capillary walls and special protective layers—known as blood-retinal barrier. The newly formed blood vessels are on the other hand extremely thin-walled and lack these special qualities of normal retinal blood vessels. These vessels fail to maintain the barrier. These blood vessels not only leak into the sensitive retina toxic substances on their way to be excreted through the kidney or detoxicated (neutralised) in liver, but often rupture to produce haemorrhage (bleeding) into the eye (vitreous haemorrhage).

While retinal oedema specially in the central area of the retina deteriorates vision, vitreous haemorrhage when massive can cause serious impairment of vision—even blindness. Often the haemorrhage gets absorbed partly or fully to improve vision. But unfortunately, the haemorrhage recurs again and again, usually resulting in loss of vision. If the vision is not lost because of vitreous haemorrhage, a peculiar growth of scar tissue on the surface of retina and later its shrinking do so when retina is pulled up causing retinal detachment.

Left to itself, the process inexorably proceeds to near loss of vision or total blindness.

### Prevention of diabetic retinopathy

People with an excellent control of diabetes, specially during the first few years of the disease seem to develop retinopathy less frequently, which progresses less rapidly. However, it is quite possible that diabetic patients who are easily controlled are suffering from a milder variety of the disease. The milder diabetes may be less often associated with diabetic retinopathy. In any case there does not seem to be any method to prevent diabetic retinopathy. Good control may be only of marginal help.

### Medical (non-surgical) methods to treat retinopathy

A number of methods have been tried in last two decades. The important among them are : (i) vitamins and food supplements (e.g., rutin, vitamin C, P, E, K, B and specially

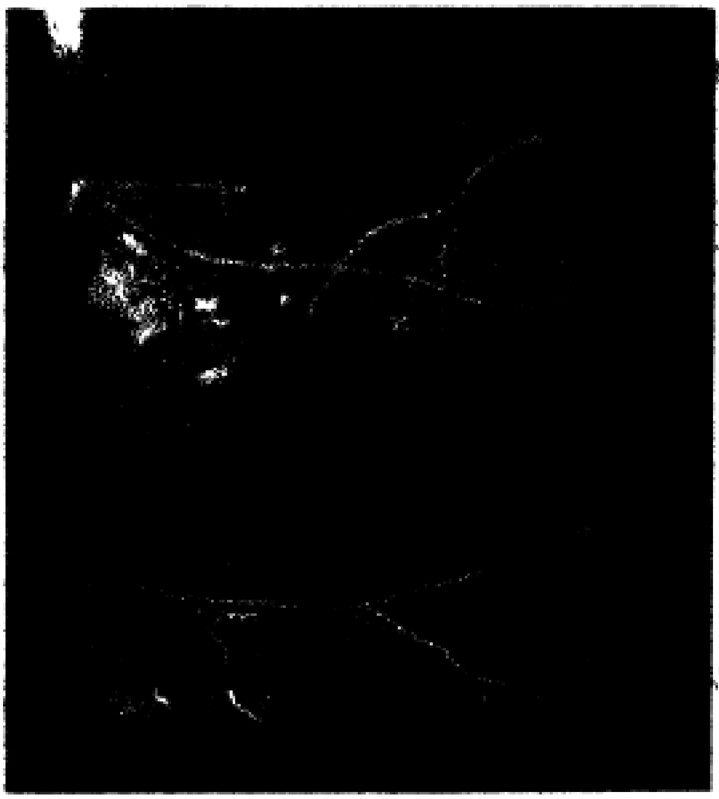

Fig. 2

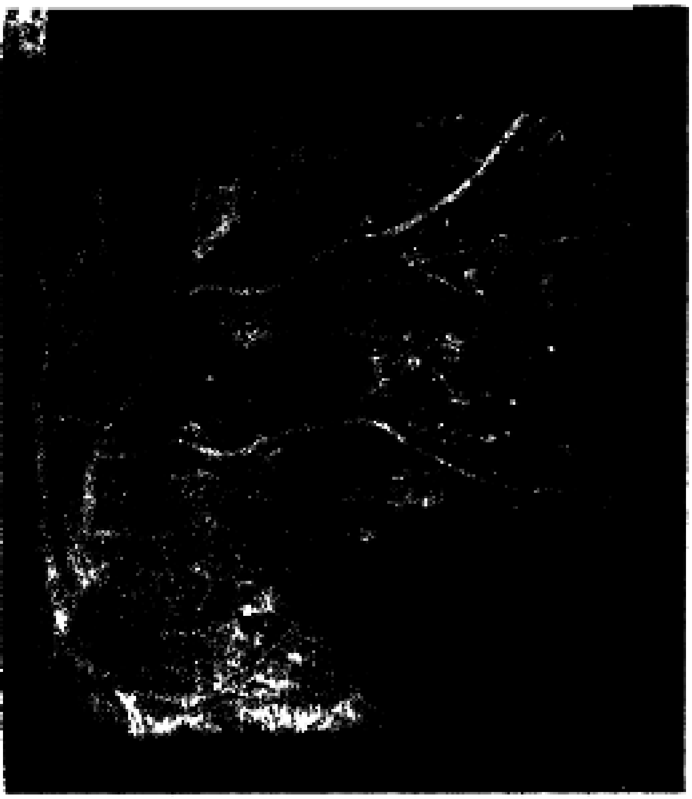

Fig. 3

$B_{12}$; (ii) special diet (e.g., fat-free, protein-rich diet), (iii) drugs affecting blood lipids (e.g., heparin, choline, methodine, para-aminosalicylate and clofibrate=Atromid); (iv) anticoagulants (e.g., coumadin); (v) hormones and anabolic steroids (e.g., thyroid, testosterone, estrogen, nor-androstenolon— Deca Durabolin, methandrostenolone— Dianabol).

Mostly because of poor understanding of the disorder, together with lack of unbiased approach, each of these medications have been favoured for some time to be ultimately discarded. Except for clofibrate (Atromid) which seems to be beneficial in reducing lipid deposits on the macula, others have no beneficiary effect on the course of diabetic retinopathy.

## Radiotherapy

Exposing the eye to graded doses of X-rays may reduce the growth of new vessels. But its dangerous side-effects on other sensitive tissues make it a totally unacceptable form of therapy.

Destruction of pituitary gland has a definite beneficiary effect on diabetic retinopathy—specially the most dangerous one called the proliferative type. However, since pituitary is the master of all hormone releasing glands, its destruction would mean death unless the vital hormones are continuously administered from outside. Obviously, this is an extremely costly and perhaps hazardous business. However, in most desperate cases, when a patient is highly concerned about loss of vision and can afford the substitution therapy, this treatment may be indicated in a small number of carefully selected cases.

## Photocoagulation

That leaves photocoagulation of the retina as the only practical form of treatment in diabetic retinopathy. This form of therapy has gained widespread acceptance all over the world since its introduction by Professor Meyer-Schwickerath (the inventor of the first photocoagulator) of West Germany in 1959. Though the majority reported encouraging results, visual deterioration and loss of vision during and after the treatment were frequently observed. With increasing experience the results continued to improve. However, it was not possible to answer such anxious and searching questions of the patients of D.R. as "What are my chances of retaining good vision? For how long? What are the risks I am taking?", etc. The reasons were many: (1) The natural progress of the disease is not uniform, and therefore, is not entirely predictable, (2) patient's vision may fluctuate; sometimes even the retinal picture changes as visualised by the ophthalmologists; and (3) because of complexity of retinal changes in diabetic retinopathy no visual recordings can be accurate. Yet it is absolutely necessary that the patient should know the odds, specially when the treatment by photocoagulation is essentially destructive. One destroys certain parts of the retina, certain potential sources of bleeding in order to preserve the function of the rest of the retina, specially the central one, used for fine vision.

In order to obtain an unbiased,

objective evaluation, one of the most elaborate, well planned and of course expensive clinical trials was launched in 1971 by the Diabetic Retinopathy Study Research Group (DRS) under the sponsorship of National Eye Institute of United States. More than 1700 patients in 15 major medical centres spread all over North America were enrolled. One eye was chosen at random while the other eye served as a control (a check). The events were recorded by colour retinal photography using the same uniform film (Kodachrome-II) before, and after each treatment at regular intervals. The improvement or deteriorations were noted in comparison to a standard set of photographs by specialists not associated with the actual treatment. All the data (bits of information) were collected and analysed centrally by the Data Monitoring Committee—a group of eye specialists and statisticians (mathematicians) specialising in biological data. They used the most advanced computer to process all the incoming information. Their work was regularly reviewed by a Policy Advisory Group—a group of specialists not involved in the study. In other words it was one of the most reliable objective studies ever conducted on such a gigantic scale. The two reports published so far establish the following :

1. Photocoagulation reduces the chances (rate) of development of serious visual loss by 57%;

2. It inhibits the progression of all varieties of diabetic retinopathy; and

3. Recovery of visual loss because of retinopathy is more frequent in treated eyes than in those not treated.

Thus it appears that the original optimism about the usefulness of photocoagulation in the treatment of this otherwise hopeless disease is to a great extent justified.

### What is photocoagulation?

It is possible to produce a burn on the retina and underlying tissue (choroid), by focussing a strong source of light. The light energy on being absorbed by the dark pigment of the choroid and in a pigment layer close to the retina, produces enough heat to coagulate the tissue —normal or diseased. Subsequently the area heals to form a scar. Thus, diseased leaking blood vessels can be destroyed. The retina can be made to stick to the choroid (as if welded). Various forms of energy have been used in the construction of a photocoagulator. The xenon lamps were the earliest and the most popular time tested source used. Earlier photocoagulators using LASER as sources of energy proved to be unsafe. However, lately, argon gas LASER has been successfully used in certain photocoagulators and are almost as safe as the xenon coagulators.

### How does photocoagulation help

The most important use of photocoagulation is to destroy the newly formed blood vessels which when ruptured lead to sudden visual loss through massive bleeding inside the eye. By eliminating these dangerous sources of vitreous haemorrhage the risk of blindness can be considerably reduced. However, just destroying the newly formed blood vessels will not be of much use in the long run, unless the stimulus for the regrowth is eliminated. The only way one can attempt to do so is to turn the oxygen starved (hypoxic) retina into scars which need no oxygen. This is done by what is known as multiple spot photocoagulation. Inevitably the retinal areas turned into scars do not function any more. However, by carefully and cleverly placing the photocoagulation marks over the areas of the retina which are least useful to man, the restrictive effect of the treatment can be so minimised that the patients usually do not realise the difference and do not complain. All the aspects of fine vision (as required to read and write) and colour vision are confined to a highly sensitive tiny area—macula (diameter 1 cm) situated at the centre of the back of the eye. The rest of the retina serves to give what is known as field of vision and night vision. When a person walks or drives in a busy road looking ahead he is also aware of the people and vehicles on either side. This is possible due to the field of vision, a function of the peripheral retina, the retina surrounding the centrally placed macula. The peripheral retina is endowed with rods which can become 1000 times more sensitive in darkness by a remarkable process of adaptation so that a man can see in darkness. Therefore, when parts of peripheral retina are destroyed by photocoagulation, it is expected that both field of vision and night vision would be affected to some extent. The reasons why patients do not usually feel the difference after treatment at the hand of a careful and experienced retina surgeon could be :

(1) spots of photocoagulation scars are so distributed as to leave functioning retinal areas all over the treated area thereby minimising the effect of field defects;

(2) since a diabetic patient with retinopathy rarely ventures out in a dark night he does not notice the difference;

(3) the retina with diabetic retinopathy has a poor sensitivity as a part of the disease. Therefore, the selective destruction of their poorly functioning retina is not as significant as it would have been in a normal retina; and

(4) the improvement of central vision (which one needs the most) as a result of peripheral treatment is often so encouraging and pleasant that such other minor functional losses involving field of vision or night vision do not bother the patients. However, these are facts. A more sensitive patient or a patient whose treatment has to be intense and extensive as in case where the retinal disease is more advanced before the treatment had

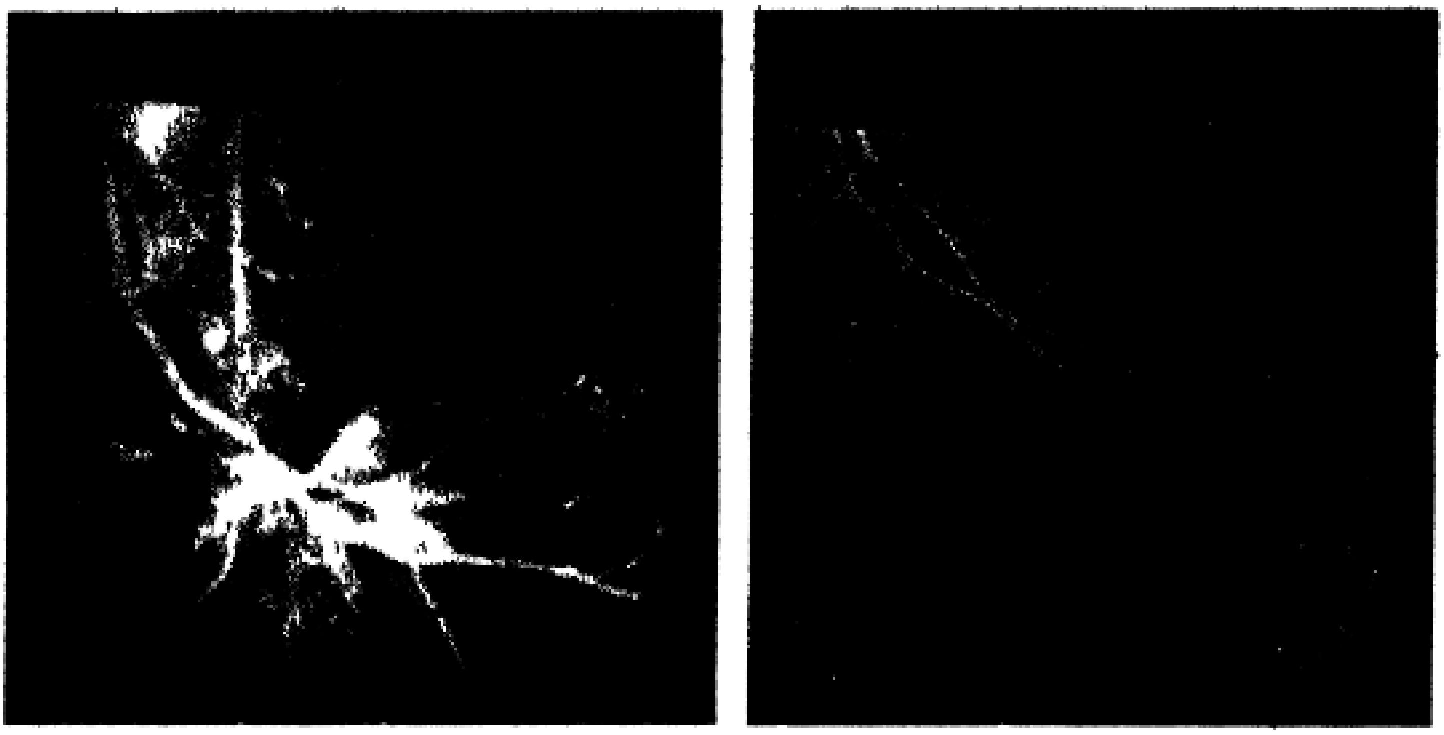

**Fig. 4** **Fig. 5**

**Flourescence photograph of diabetic retinopathy before (4) and after (5) treatment by photocoagulation. Note the disappearance of leaking newly formed blood vessels after treatment**

been started, these limitations of visual function could be disturbing. It is always advisable that all patients are informed about the good, as well as not so good, aspects of all treatment including their treatment with photocoagulation.

The best that has been claimed about this treatment is that it helps to preserve useful vision for a longer period; it staves off disaster in the form of blindness. But, does it eliminate such possibility? The answer is : though it considerably reduces the chances of blindness, it does not eliminate the possibility. It has been found that when treated early it significantly slows the progress of diabetic retinopathy and long-term prognosis (prospects) in maintaining good vision is far better than treatment started late.

### Fluorescence photography as an aid to precise treatment

Before planning photocoagulation a complete picture of the abnormalities in the retina is obtained by a very special photographic system—fluorescence photography. Finest aneurysms (dilatations), capillary closures, leaking capillaries and neovascular areas are outlined with amazing clarity (Fig. 3). Such photographic studies are important prerequisites to accurate and adequate photocoagulation.

Sodium fluorescein is a dye. When it is illuminated by blue (short wave length) light it emits a strong light in yellow green spectrum. The substance is completely nontoxic. When injected intravenously it is totally and easily eliminated through the kidneys. Normally the dye does not leak into the retina and the brain. However, in diseased conditions of the blood vessels, as in D.R., the leakage becomes remarkable (Fig. 4). The dye while in circulation in the blood vessels or leaking out to stain the retina can be dramatically visualized when the illuminating light of an ophthalmoscope is blue. When a special fundus camera (camera to photograph the inside of the eye) is fitted with suitable filters to take the contrast photograph the process is known as fluorescence photography.

### What a patient of diabetes must do to help himself ?

Diabetic retinopathy appears and progresses at different pace in different individuals. Very often the vision remains good till the retinopathy has progressed too far. Since the results of treatment started early is far more gratifying than when started late in the disease process, it is clear that diabetic retinopathy must be detected at the earliest stage and appropriate treatment is started at a suitable moment. Therefore, the logical steps a diabetic must take is to get himself examined by a retina specialist at regular intervals. Often at a very early stage the diagnosis may be missed if the retina is examined only by an ophthalmoscope (an instrument to look into the eye). As mentioned earlier, it is through fluorescence photography that the earliest and the minutest of changes in diabetic retinopathy can be detected. Besides, by such photography one can keep a permanent record of the diabetic retina. Such photographs become very useful in assessing the progress of the disease with or without treatment. As such, periodical study by fluorescence photography is a clever thing to do.

*Cryotherapy*. Lately extremely low temperature (−70°C) probes (cryo-probes) have been successfully used to discourage or even produce regression of newly formed blood vessels. It promises to be a valuable complement to photocoagulation therapy.

## Vitreous surgery

A person with a massive vitreous haemorrhage which does not clear up, or with a diabetic membrane in front of the retina or a retinal detachment caused by the contraction of such a membrane is considered to have got too advanced stage of D. R. for effective treatment. Lately a system of surgical techniques have been developed by the pioneering efforts of such giants in the field as Connor O' Mallay of California; Robert Machemer of Dukes University Eye Centre, Durham; Gholam Peyman of University of Chicago and K. Kloti of University Eye Clinic, Zurich. Besides, an encouraging number of younger retina surgeons are engaged in helping these seemingly hopeless cases. The blood-filled vitreous is cut and sucked away in tiny bits while the vitreous removed is replaced by a suitable clear fluid. The fine vitreous membranes are cut by micro-scissors and peeled by special micro-forceps under an operating microscope. From among the hopeless cases, vision is restored in as many as 30% by vitreous surgery. With accumulating experience and improved equipment and technique the results are bound to improve. In India, vitreous surgery is slowly getting into its strides. In conclusion, it may be said that till man understands the mechanism of development of diabetic retinopathy and finds a fundamental solution to prevent or treat it, photocoagulation provides the best and only meaningful treatment. Vitreous surgery is the only hope for the advanced and traditionally hopeless cases.

## Further reading

1. Diabetic Retinopathy Study Research Group: Preliminary Report on Effects of Photocoagulation. *Amer. J. Opthal.*, 81; 1-14, 1976.
2. Diabetic Retinopathy Study Research Group: Photocoagulation Treatment of Proliferative Diabetic Retinopathy, *Trans. Amer. Acad. Otolaryng.*, 85 : 82-106, 1978.
3. Meyer-Schwickerath, G., Light-coagulation, *Buech. Augenarzt*, 33: 1. 1959.
4. Okun, E., Johnston, G. P. and Boniuk, I., *Management of Diabetic Retinopathy*, Mosby Company, St. Louis, 1971.
5. Patnaik, B., Kalsi, R. and Chari, P., *Cryopexy in the Management of Diabetic Retinopathy*, presented at the XXXIX All India Ophthalmic Conference, Feb. 1980.

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## DNA HELIX (*Continued from page 503*)

DNA could be "forced into" SBS configuration.

It is hoped that the helix controversy shall be finally resolved in the near future by more strenuous mental exercises, and by the use of newer biophysical tools like the resolution of single crystal structures of a variety of short DNA lengths of known base sequences, coupled with more exact energy calculation data for the various types of DNA structures.

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## SCIENCE SPECTRUM (*Continued from page 541*)

it, and, depending upon the size of the insect, it is either bitten or wrapped in silk or both. Large insects like moths and butterflies, crickets, odonates, etc., which can damage the web by their fluttering, are at once immobilized by injected venom by the spider. Smaller insects, if not consumed immediately, are enmeshed in silk but not killed. The spider eats the living insect at leisure. In this way it gets fresh food!

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*Deptt. of Zoology*
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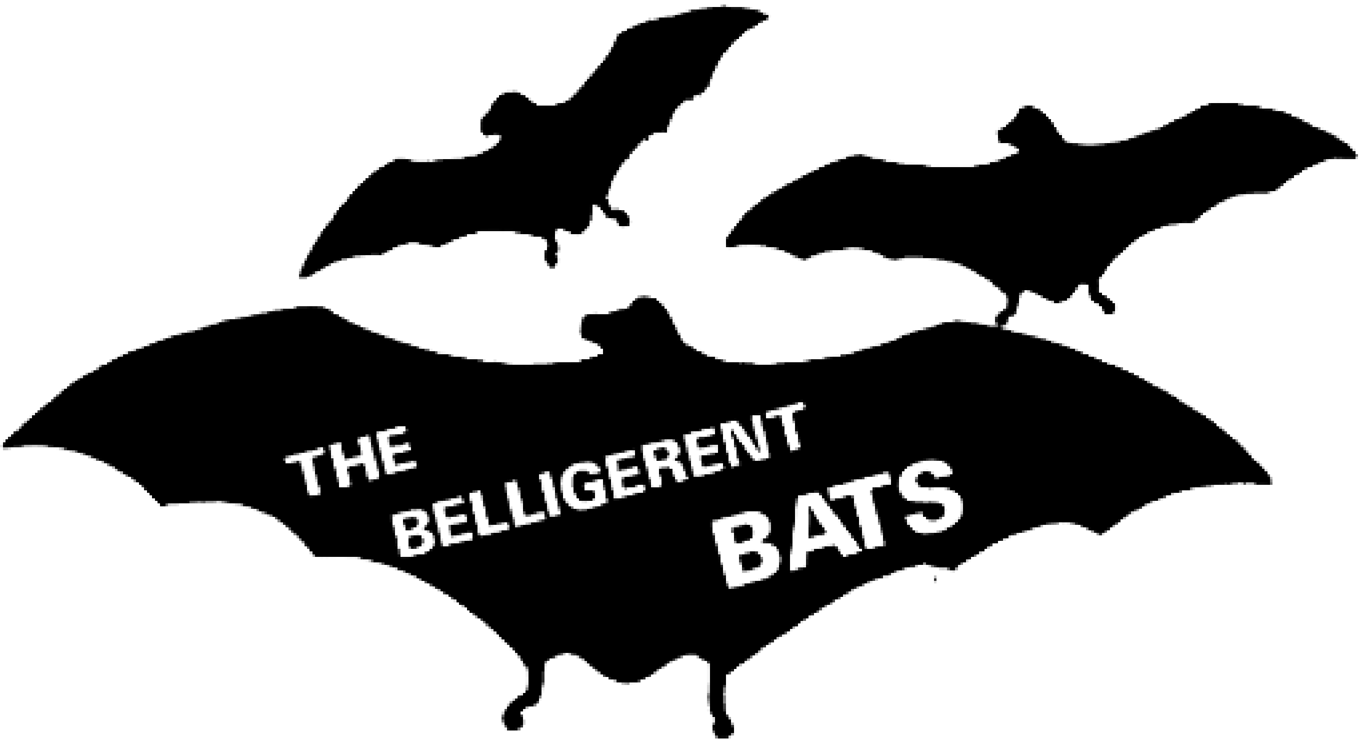
*Aligarh-202001* (U.P.)

**Bats have been looked upon with fear for centuries, which may be the reason why so little is known about them. Only in recent years have their bio-medical, agricultural and economic importance been realised**

D. P. JAROLI

S. B. LALL



# THE BELLIGERENT BATS

FOR centuries bats have evoked a mixed feeling of curiosity, revulsion, fear and bad omen in man. Many legends, anecdotes and horrifying dreams causing acute psychosis are linked with these animals. In geographical distribution and population dynamics bats represent the second largest order of mammals. Bats are mammals in that they have an external ear, a body covered with fur or hair, constant body temperature, non-nucleated red blood corpuscles, four-chambered heart with a distinct systemic and venous circulation, and a diaphragm between thoracic and abdominal region. The females have functional mammary glands. The position of these glands is peculiar—axillary as in the case of flying foxes (*Pteropus giganteus giganteus*) and abdominal as in *Rhinopoma kinneari*. The number of these glands may vary from a single pair to several pairs. A fold of skin between the body and the forelimbs called patagium, supported by flight muscles, enables these animals to make extensive aerial excursions and manoeuvres.

Bats are nocturnal animals and begin their daily exodus at dusk from their roosting sites where their numbers can be anything between 50-400 or more as in the case of flying foxes (roosting on mango, guava, date palm and eucalyptus trees in Udaipur) or several thousand as in case of insect-eating microchiropterans (e.g., *Rhinopoma kinneari*, *Taphozous longimanus* and *Megaderma lyra*) which roost in tree holes, rock crevices, abandoned houses, barn yards, caves and tunnels (Figs. 1, 2 and 4). At dawn, immigration to the roosting sites begins with each member of the roost occupying its position on the tree branch as in the case of flying foxes (Fig. 3) or anchoring on their perching sites in the abandoned dwellings as in microchiroptera (Figs. 5-6). The roosting posture may also vary (see Figs. 1 and 5 for comparison).

The hunting abilities of the microchiroptera have no parallels. With their extremely sophisticated echo-location sensor system they are not only able to locate a small prey (e.g., mosquito) but also chase it and eat it in mid-air. Even the best of the man-made radar systems cannot compete in efficiency and function with the sensory apparatus of bats. In addition to assisting in hunting and capture of prey, it also facilitates navigation in the dark and homing back to the roosting sites with a re-

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markable degree of accuracy. The flying foxes, on the other hand, do not have a echolocation sensor system but have an acute nocturnal vision, coupled with sharp auditory and chemosensory apparatus. Food preferences of bats range from blood of vertebrates, including man (e.g., vampire bats) to predation on crabs, fishes, fruits of various kinds and flower nectar. Extensive morphophysiological adaptations are seen to support such diverse feeding habits in their various organs and organ systems. Fruit-eating bats are credited with being the agents for the dispersal of seeds.

An extremely intricate social organisation exists in bats, involving constant interaction between males and females which reaches its peak during breeding season and soon after. Roosting sites of bats are never silent. Screaming, vocalisation, aggression with free use of the projections of the forelimb are common between males and females and younger members of the colony (Fig. 1). Males are polygamous and maintain a "harem" of females. There is a hierarchical relationship between males and females. Unmated and pregnant females dominate over juvenile or reproductively quiescent females. This behaviour is similar in flying foxes and *Taphozous longimanus*.

Courtship activities are elaborate with considerable vocalisation. Males of flying foxes chase females on the tree till the latter reaches the end of the branch. Copulation occurs in a canine-like fashion with males mounting the females from the dorsal side. The females are grasped by the males with their mouth to keep the head in position. Males also embrace the females with their patagium, using the digits for anchorage. Like dogs, the penis is of the fibroelastic type. Concomitant adaptations in the female genitalia occur to hold the penis in position for an extended duration of time. Males and females interlocked in such a manner have been observed by the authors in case of flying foxes, *Taphozous longimanus* and *Rhinopoma kinneari*. W. A. Wimsatt, and F. Kallen (1952: Cornell University, USA) observed interlocked (copulating) pairs during their entire period of hibernation. The copulating pair enters into a state of torpor perhaps due to sudden changes in the environmental conditions.

One of the unique abilities of the females of some species, e.g., *Pipistrellus* spp., is to store spermatozoa received from the male during sexual act in a receptacle of their genitalia. The sperms are able to survive for long duration and retain their fertilising ability. In many species, copulation takes place in spring; fertilisation of the egg takes place several months later. Delayed implantation of the blastocyte is exhibited by several species. After becoming pregnant, the females cut off their interactions with males and fly off to remain in isolated confinement. The authors have also trapped females of flying foxes that did not follow this pattern but remained perched on a mango tree branch, away from the company of males. Such females did indulge in nocturnal flights for foraging activities.

In flying foxes, the time of birth of the young ones coincides with the flowering and fruiting season of guava and mango trees. This observation from Udaipur is in consonance with the reports of other investigators from other geographical areas of the world where fruit-eating bats are found.

Suckling young ones remain on the mother's body gripping the mammary nipples with their mouth. Flying foxes have been observed to carry their infants during early phase of the weaning, but later they are left behind on the roosting sites during nocturnal excursions of the mother who travels long distances for foraging activities. Weaning period varies from 1-3 months in micro-and mega-chiropteran bats. Climatic factors, nutrition, etc., seem to have some bearing on this. Mother-infant relationship during weaning is based on sensory cues.

The bio-medical, agricultural and economic importance of the bats is now beginning to be realised. The large roosts of bats near human settlements have, of late, been considered to be a potential hazard. Humans may contact a number of zoonoses from bats. A variety of micro-organisms, e.g., viruses, bacteria, mycoplasma and protozoans, capable of causing diseases in man, have been isolated from bats and there are presumably others which await identification. Rabies is common in bats. Bats also harbour a variety of endoparasitic helminthes and they also serve as favourable site for many blood-feeding arthropod vectors, thus establishing a biological link with man. The role of bats as "reservoir hosts" for pathogens and parasites needs careful study.

From agricultural point of view, fruit-eating bats are a menace in many areas causing extensive but yet unassessed damage to guava, mango, eucalyptus, date palm and other plantations.

As many of the roosting sites in Udaipur are in close proximity to the aquatic reservoirs used for supplying drinking water to human populations, a threat to the outbreak of unidentified diseases is quite real. The authors have observed flying foxes near the water surface level, dip their mouth and sip water while in flight (Fig. 4.) Droppings and urine of such bats contaminate water and are the potential source of yet unidentified health hazards.

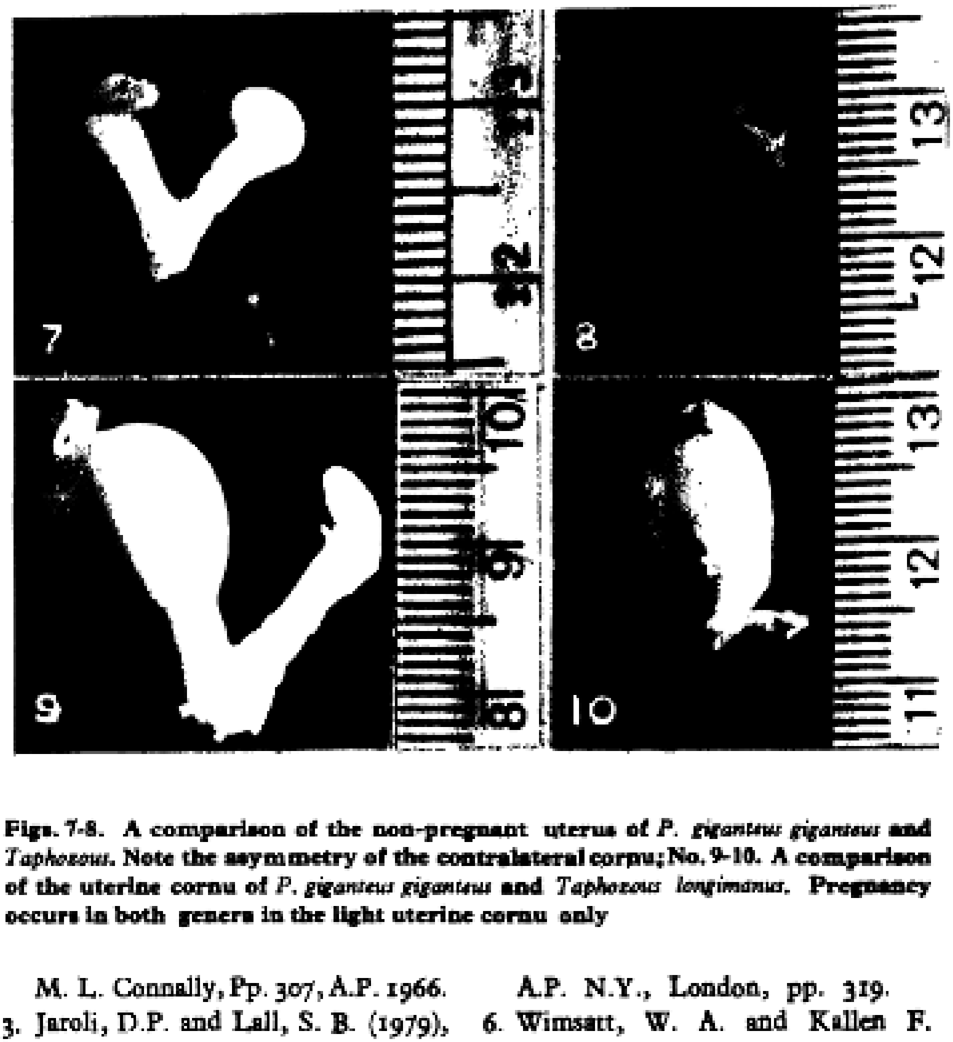
Bat guano and guano-enriched soil is a source of saltpeter for the production of gun-powder which was used during war of 1812, the civil war and in Mexico at various times. During World War II, the "Project X-Ray" of the U.S. Army tested the efficacy of bats fitted with small incendiary bombs and released in

**Figs. 1-6.** **Colonies of *Pteropus giganteus giganteus* on mango tree. Note circled pairs (males and females in interaction) (1); Nursery colonies of *P. Giganteus giganteus* on mango tree (from March to late July) (2); Immigration pattern of ← *P. g. giganteus* at dawn. Some bats can be seen occupying a landing posture prior to perching; while others showing fully spread patagium indicating the posture of the animal in flight (3); A herd of *P. g giganteus* (circled) flying over the water of lake Pichola, Udaipur (4); Roosting colonies of *Taphozous longimanus* in an abandoned palace used for storing grass fodder in Udaipur (5); Immigration pattern of *Taphozous longimanus* at dawn. Note the difference with the flying foxes in Figs. 1-2 (6)**

great numbers from aeroplanes to cause damage to enemy installations. *Tadarida brasiliensis*, made dormant by chilling, were fitted with small bombs (about the size of the bats body). Thousands of such bats were placed in cells within a large container which when lowered by parachute, would open and release the bats. Alighted bats chewed the string, dropping its bomb which exploded (Constantine, D.G., 1970, U.S. Deptt. of Health, Education and Welfare, Atlanta, Georgia, USA).

Much, therefore, needs to be learnt about the role of the bats in the ecosystem, vis-a-vis their frugivorous, piscivorous (fish-eating), carnivorous, entomophagous and haematophagous habits. Their role includes causing economic losses to horticultural plants, transmission of pathogens and parasites and suppression of insect pest populations, etc. In many parts of the world bats are consumed as food. Fat obtained from their body is believed to have aphrodisiac and anti-rheumatic properties. A careful study and electronic simulation of their ecolocation sensor system is of significance in remote control sensing.

So, although humans shun bats on account of the age-old bias, an understanding of the ways of life of these strange aerial mammals is of utmost importance to man.



**Figs. 7-8. A comparison of the non-pregnant uterus of *P. giganteus giganteus* and *Taphozous*. Note the asymmetry of the contralateral corpu; No. 9-10. A comparison of the uterine cornu of *P. giganteus giganteus* and *Taphozous longimanus*. Pregnancy occurs in both genera in the light uterine cornu only**

## Further reading

1. Wimsatt, William A. (Ed.) *Biology of bats, Vol. I-III* A.P., London, 1970, 1977.
2. Loosli, R., Zoonoses in common laboratory animals., *In Husbandry of Laboratory Animals* (Ed.) M. L. Connally, Pp. 307, A.P. 1966.
3. Jaroli, D.P. and Lall, S. B. (1979), A comparison of uterine phosphatases of non-pregnant and pregnant *Taphozous longimanus*, *Curr. Sci.*, **48**, 1200.
4. Jaroli, D. P. and Lall, S. B. (1980), Ovarian and uterine acid phosphatases of lactating females of *Pteropus giganteus gignateus* Brunnich (Megachiroptera: Mammalia), *ibid.*, **49**, 135.
5. Constantine, D. G. (1970), Bats in relation to health welfare and economy of man, *In Biology of Sats Vol. II* (Ed.) William A Wimsatt, A.P. N.Y., London, pp. 319.
6. Wimsatt, W. A. and Kallen F. (1952), Histophysiology of the chiropteran penis, *Jour. Morp.*, **44**, 1-52.
7. Wimsatt, W. A. (1979), Reproductive asymmestry and unilateral pregnancy in chiroptera., *J. Reprod. Fert. Symposium Report*, No. 14, 345-357
8. Hutchinson, G. E. (1950), Survey of contemporary knowledge of biogeochemistry 3. The biogeochemistry of vertebrate excretion., *Bull Amer. Museum. Natur. Hist.*, **96**, 1-554

# SCIENCE SPECTRUM

## Catastrophe theory

ONE may be tempted to link catastrophe theory with sudden and violent changes in the features of the earth or the Big Bang hypothesis which attempts to explain the apparent expansion of the universe from primeval atom or cosmic egg. However, such is not the case. Actually, catastrophe theory is a new mathematical method conceived by the French topologist Rene Thom in the early 1960s.

The smooth continuous processes, with which we are familiar can be effectively handled with the help of calculus. In nature, however, there are several events which are characterized by sudden jumps or abruptness. For example, water flows in a tube smoothly but when the flow velocity crosses a certain limit turbulence sets in. The word catastrophe was used by Thom to describe sudden effects as a result of smooth changes in one or more parameters. In French catastrophe conveys not necessarily a sense of disaster and is milder than the English word.

### Zeeman catastrophe machine

We now describe a simple device invented in 1969 by Prof. E. C. Zeeman (Fig. 1), which demonstrates catastrophes. It consists of a circular cardboard disc mounted on a wooden board. The disc is pivoted at the centre O to the board by a drawing pin and can rotate freely. Another drawing pin is placed at point Z on its circumference and two elastic bands are looped around it in a reef knot (Fig.2). One loose end of the elastic is fixed at Y and the other end is attached to a pointer X held in the hand. We may choose the radius of the disc as 3 cm, OY as 12 cm and unstretched length of each elastic as 6 cm.

If we move X as shown in Fig. 1, we find that the disc adjusts itself smoothly but at certain points it jumps to a new position. This jump is referred to as a catastrophe. The points where the jump occur lie on the curve PQP'Q'. If this region is avoided there are no jumps. The figure is called a diamond or the bifurcation set B and is symmetrical about the line OY. It is also noticed that when X enters B as shown in Fig. 1, there is no jump but there is a jump when it moves out.

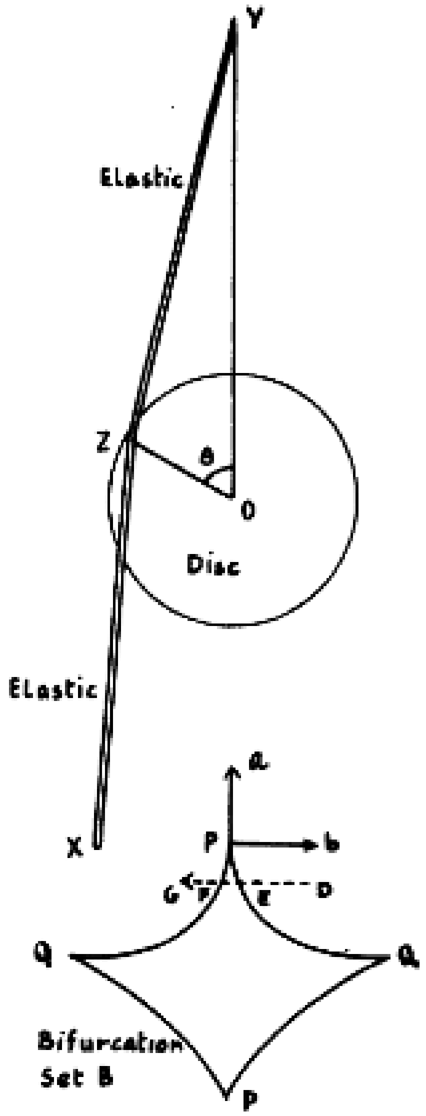


Fig. 1. The Zeeman catastrophe machine

The point X moves in a two dimensional plane, called the control space C. Any point in this plane can be represented by the cartesian coordinates (a, b), where a and b are known as the control parametres. For a complete description of the system it is necessary to specify angle θ, which is the angle between the lines OY and OZ, θ is known as the state variable.

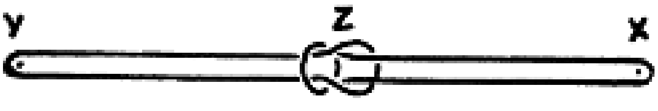


Fig. 2. The reef knot

The variation of the potential energy as the point X moves along the line DEFG is shown in Fig. 3. When point X is outside the region B there is only one minimum which corresponds to the equilibrium position of the disc. In case point X is inside the region B there will be two minima and two positions of equilibrium. In such a case the disc prefers to stay in the original minimum position. As we move out from B the first minimum disappears and the disc jumps to the second minimum. It may be seen that a smooth variation has produced a jump (along DEFG only b varies). If both a and b vary then also there will be a jump on crossing the region B.

The potential variation can be visualized by means of the catastrophe manifold M, which is a surface in (θ, a, b) space, and is shown over the region B in Fig. 4. A vertical line drawn on the control space C cuts M in one point if X is outside the cusp and at three points if it is inside it. If X is moved along the line DEFG, as we reach F, the system can only stay on M by jumping from the lower to the higher sheet. And, if we retrace back the path of X the jump will be encountered at E and not at F. If the point X is outside the region B there will be no jumps in the behavioural space M.

The curve on the surface where the upper and lower sheets fold over into the middle sheet is called a fold-curve and its projection down into the horizontal plane C is the familiar bifurcation set B. Although the fold curve is a smooth curve the bifurcation set has a sharp point, forming a cusp and that is why we have the name cusp-catastrophe.

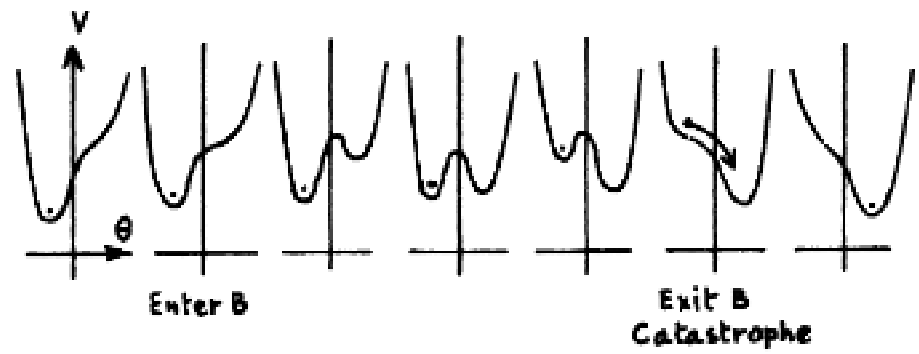


Fig. 3. Variation of potential 'V' or 'X' runs along the dotted line DEFG in Fig. 1

Table 1

| | | *dimX* | *dim C* | *Function f* |
|---|---|---|---|---|
| Cuspoids | Fold | 1 | 1 | $1/3\,x^3 - ax$ |
| | Cusp | 1 | 2 | $1/4\,x^4 - ax - 1/2\,bx^2$ |
| | Swallow tail | 1 | 3 | $1/5\,x^5 - ax - 1/2bx^2 - 1/3\,cx^3$ |
| | Butterfly | 1 | 4 | $1/6\,x^6 - ax - 1/2bx^2 - 1/3\,cx^3 - 1/4\,dx^4$ |
| Umbilics | Hyperbolic | 2 | 4 | $x^3 + y^3 + ax + by + cxy$ |
| | Elliptic | 2 | 3 | $x^3 - xy^2 + ax + by + c\,(x^2 + y^2)$ |
| | Parabolic | 2 | 3 | $x^2y + y^4 + ax + by + cx^2 + dy^2$ |

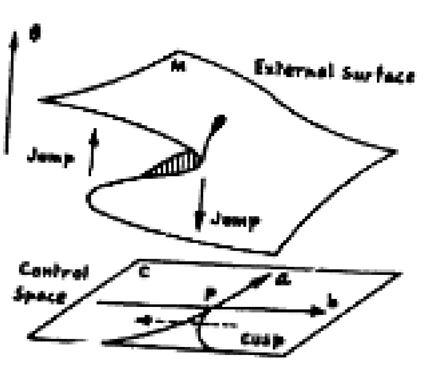


Fig. 4. The cusp catastrophe illustrating the control parameters a & b and the state variable θ

Incidentally, the cusp catastrophe has many applications. The aggression mechanism of the dog and other species can be understood by the cusp catastrophe surface by taking rage and fear in control space and its behaviour like fighting or fleeing as state variable. The model can also be used to study the stock market trends. Zeeman has shown great ingenuity in applying this model to understand the dynamics of the heartbeat. The manic depressions of a patient can also be studied with its help. It is employed in the study of the stability of ships and oil rigs as well as the mechanism of prison riots.

## Thom's seven elementary catastrophes

Thom has given the number of catastrophes that can exist if dimension of the control space is five or less. The number of catastrophes depends only upon the dimension of C and not on the dimension of the state space, as follows :

Dimension of C : 1 2 5 6
Number of catastrophes : 1 2 1 ∞

When dimension of C is unity there is only one catastrophe called the fold catastrophe. The geometrical figure that corresponds to it is a sheet of paper folded with its top and bottom surfaces parallel to one another. When dimension of C is 2 we get a fold catastrophe as well as a cusp catastrophe. We have already discussed the geometrical figure corresponding to a cusp catastrophe. When dimension of C is 3 the catastrophes are more complex. The additional catastrophes are known as the swallow tail, hyperbolic umbilic and the elliptic umbilic. The swallow tail has been used to decipher the division of cells in growing embryos. The hyperbolic umbilic has been used for understanding the wavy image observed on viewing a powerful light through frosted glass. Scientists have applied the elliptic umbilic catastrophe to problems involving flow of fluids. If the dimension of C is 4 we have two more catastrophes known as the butterfly and the parabolic umbilic. The butterfly has been used to analyze *anorexia nervosa*, a disorder suffered mainly by adolescent girls and young women. The parabolic umbilic has been used in linguistics problems. Higher dimensional catastrophes corresponding to C equal to five have not been given special names.

Corresponding to every elementary catastrophes there exists a standard model. In Table 1 are given some formulae for f. The parameter for C are $a$, $b$, $c$ and $d$ and the variables for X are $x$ and $y$. For the cuspoids M is given by $\partial f/\partial x=0$ and for the umbilics, M is given by $\partial f/\partial x=\partial f/\partial y=0$. The fractions in the function $f$ vanish when differentiation is done to get the equation for M. The cusp-catastrophe, for example, is given by $\partial f/\partial x=x^3-a-bx=0$.

Though catastrophe theory has a solid mathematical background and requires good knowledge of topology and multidimensional geometry, etc., it can be understood and appreciated to a fairly good extent even by persons who possess only a smattering of mathematics. The theory has found wide applications in such diverse fields as elasticity, aggression, emotions, war and economics. In complex biological systems it has provided a model where none was thought possible. It provides a mathematical model for a few most obvious measurable quantities. However, it does not elaborate how to select them. The emphasis seems to be more on the qualitative side than on the quantitative side.

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# Atomic absorption spectrophotometry —a potent tool for metallurgical industries

WITH the rapid growth of metallurgical industries and their competition in the market, the urgency of rapid analytical results cannot be underestimated. Due to this, the superiority of an instrumental technique over conventional wet analytical method is becoming an accepted fact. However, one should remember that any technique to be adopted must be rapid, accurate and reproducible, i.e., its accuracy and precision should be high. Sample preparation and instrumental operation must be simple and economic. In addition to these features, the instrument should be robust, versatile and less expensive. If these criteria are examined for the available instrumental methods, Atomic Absorption Spectrophotometry (AAS) is much closer to them. If one requires trace elemental analysis, the instrument is all the more essential.

Field of instrumental analysis is very vast and AAS is one of the latest developments; but probably no other technique has seen such a rapid growth as AAS during the past two decades. Though it is very useful for biological, criminological, toxicological, agricultural and clinical laboratories, it is a must for a laboratory analysing metallurgical and mineral samples. As this does not demand intricate sample preparation and separation, it is an ideal tool even for non-chemist, biologist and engineer. Its versatility is clear by the fact that it allows more than 70 elements to be determined from trace to appreciable range.

## History

The date of birth of flame technique may be traced back to as early as 1756 when a 26 year old British (Glasgow) scientist Thomas Melvil studied the flames produced by spirit, nitre, sea salts, etc. In 1955 the Netherland's scientists C.T.J. Alkemade and J.M.W. Milatz realised the tremendous potentiality of absorption in analysis, but major credit for the development of AAS as a analytical tool goes to Australian scientist A. Walsh and his colleagues in CSIRO, Division of Chemical Physics, Melbourne, Australia. Thus we find that in such a short period, in terms of scientific development and communication, AAS has established itself fully and has widely been accepted as a vital area in chemical analysis.

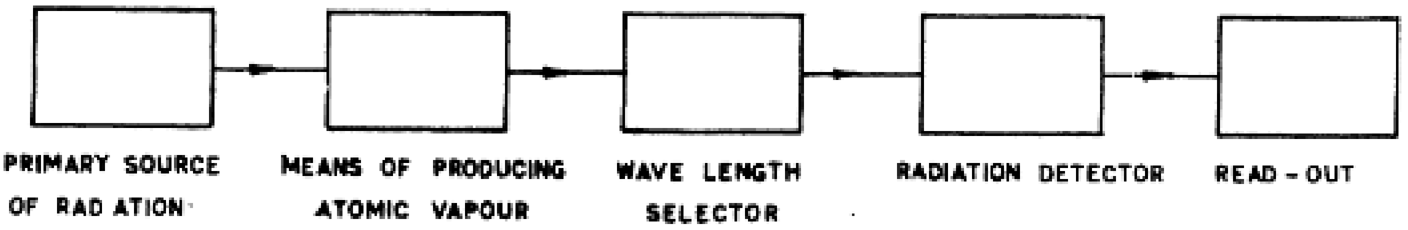

Fig. 1. Primary requirements for atomic absorption spectrometer

### Principle

If a solution (aqueous or mixed) is aspirated into flame desolvation takes place. The compound breaks into atoms and consequently an atomic cloud is formed containing atoms mostly in the ground state, i.e., lowest energy state, because temperature of the flame (even in furnace, in flameless technique) is not high enough to bring these atoms in different excitation states. When this population of atom is irradiated by a characteristic specific energy source, the atoms immediately absorb the resonant radiation at a definite wavelength characteristic of the analysate forming the atom population. The absorption of the energy depends upon the number of atoms, i.e., its concentration. Therefore, a series of standard solutions are aspirated for calibration. When graph is ready or instrument is calibrated for a particular element, the unknown solutions are sprayed. In many instruments percentage of the elements is directly obtained if properly calibrated. Even if the instrument is not sophisticated, strength of the unknown is calculated from the data obtained by running the standards.

### Procedural considerations

The instrument utilised for this purpose is called atomic absorption spectrophotometer. It consists essentially of the following components : (a) stable energy source, (b) flame system of flameless device, (c) monochromator, (d) photomultiplier, and (e) readout system.

At present most of the modern instruments contain microprocessor (mini computer) for controlling various parameters, but the essential components remain the same. The primary requirements of AAS have been indicated schematically in Fig. 1.

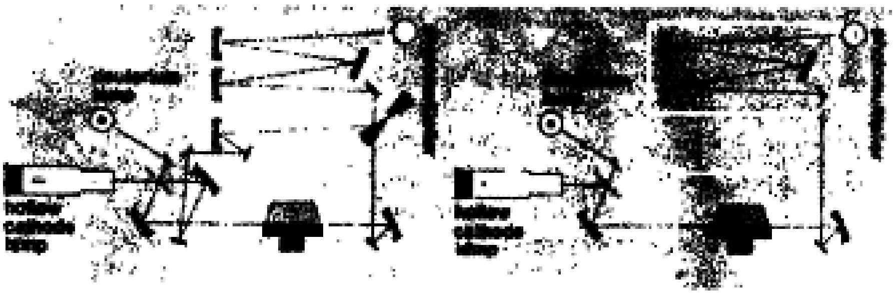

Fig. 2. (*Left*) Double beam optical system; (*Right*) Single beam optical system

The energy source is usually a hollow cathode lamp or an electrode-less discharge tube. A hollow cathode lamp or the tube contains only the element which is being analysed and therefore, the emission spectrum contains only the lines of that element. The spectral lines originate from an atomic process and are therefore of a similar width to that of absorption lines. Most common flames used are air-acetylene and nitrous oxide-acetylene. These two flames cover almost entire range of the elements to be analysed by AAS. Flameless device for atomisation is also gaining momentum now.

On account of line source used in AAS, it may be inferred that the monochromator need not be of high resolving power, because it is used only to separate the resonance wavelength from lines due to impurities in the cathode and filler gas. Prism or grating monochromator is used for this purpose. Mostly photomultipliers are used as detectors. The output from the photomultipliers is directly proportional to transmission. In a simple readout system, this is fed through a linear amplifier directly to a meter. The absorbance signal may be read through a meter, recorder or digital readout system. Facilities for scale expansion and curvature

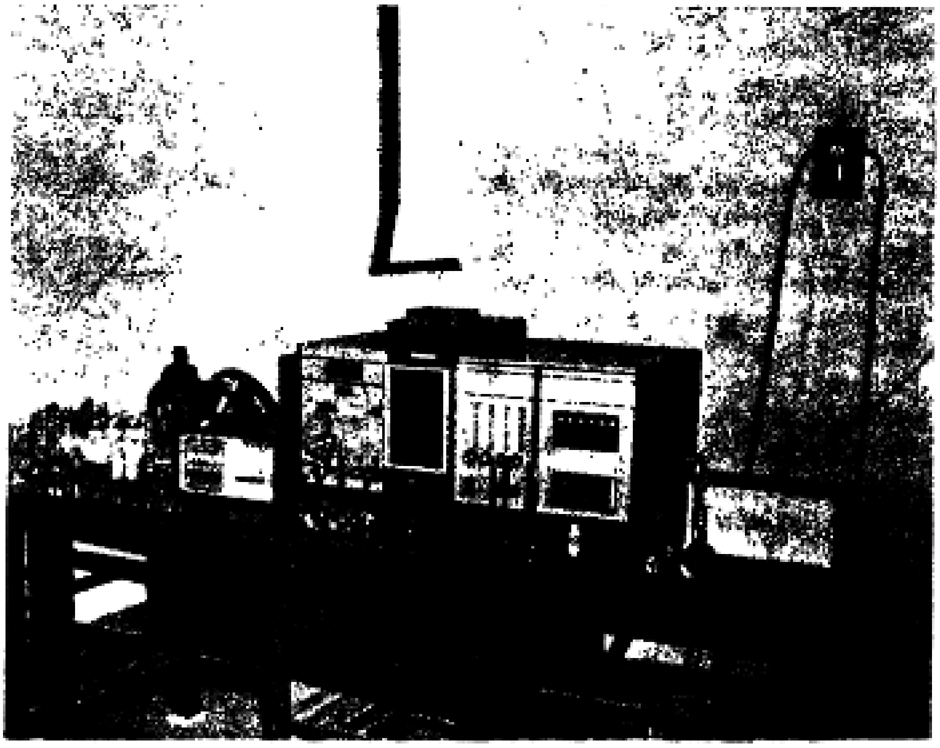

Fig. 3. Atomic absorption spectrometer

correction are also included in most of the instruments.

In operation, the digital display system or meter is adjusted to zero, when a blank solution is sprayed into flame. Zero value indicates that no absorption of light is taking place. When sample solution is aspirated in the flame, light is partly absorbed by the ground state atoms. The absorption is directly proportional to the concentration of the analyte. Strength of the sample is calculated as described earlier.

Both single and double beam instruments are used for analysing the constituents. In single beam system, the light from the lamp is passed through the flame as a single beam to the monochromator and focussed on to the photomultiplier. In the double beam system, the light from the source is split into two beams. One beam passes through the flame, while the second, called reference beam, is deviated around it. The two beams combine beyond the flame and their ratio is electronically compared. The two systems have been illustrated in Fig. 2.

### Other useful instruments

Many metallurgical industries use spectrograph for their routine analyses. This is a simple technique and elaborate sample preparation is not required; but measurement of spectrum intensities are long and tedious. Further, it requires skill and experience. In case of Direct Reading Spectrograph, the operation and calculation is simple and quick but cost of the instrument is very high. Availability of suitable standards is another problem.

X-ray fluorescence spectrometer is another important analytical instrument for such industries. Versatility of the instrument is very high. Elements having At. No. 9 and above may be estimated quickly with little sample preparation. Price of the instrument and interelemental effects are serious drawbacks of this technique. Though some modern instruments provide computerised materix correction system, their high cost is still a great problem for many industries. Purchasing of such instruments should only be considered, when number of samples is sufficiently large to justify huge investment.

Long use of UV-visible spectrophotometer has established its place in industries and research institutions. Large number of reagents are available for producing coloured solutions but very few are specific and spectral interference is large. Chemical separation is frequently necessary to avoid interference. Such treatment is usually employed even in polarography unless a polarograph capable of resolving closely adjacent wave is used.

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# Saponins

MOST of us are aware of the fact that soapnut (*Reetha*) or *Shikakai* when shaken with water produces lather or foam. Ladies take advantage of this property and use them to shampoo their hair. Soapnut has also been an age-old material for washing woollens. But not many people know that this lathering property of soapnut or shikakai is due to a chemical substance called saponin which is derived from a Latin word *sapo* meaning soap. The term saponin is applied to a group of natural products which possess in common the property of producing lather or foam when shaken with water. Chemically saponin is defined as one of a class of glycosides of high molecular weight and characterised by high solubility in water with the property of persistent foaming of its aqueous solutions. Saponins give a greenish colouration with ferric chloride in acidic alcoholic solution. Being a strong surface active agent and readily absorbable material they lower surface tension.

Saponins are widely distributed in the plant kingdom—it has been found to be present in about 500 genera of the plants. From animal kingdom there is an isolated report of the presence of saponin in sea-cucumber and starfish.

### Chemical nature

Since saponins belong to the group of glycosides, they easily undergo hydrolysis in presence of mineral acids and yield one or more sugar units and a non-sugar moiety, or the aglycone commonly known as sapogenins which are compounds having polycyclic ring systems. On the basis of the chemical nature of sapogenins, saponins are broadly classified into two groups.

(1) *Steroidal saponins* are derived from the same tetracyclic ring system as in sterols, bile acids and cardiac aglycones (Fieser steroids). Among the saponins of this group are digitonin from foxglove or digitalis, dioscin from dioscorea, sarsasaponin from sarsaparilla and yucca, etc. These sapogenins are composed of 27 carbon atoms and carry a spiroketal side chain (Fig. 1).

(2) *Triterpenoidal* saponins are the most widely distributed saponins in plant kingdom. These saponins have been known for more than a

century and a great variety of them have already been isolated and characterised. The number and type of sugars attached to a particular sapogenin distinguish the saponins. The triterpenoid (Fig. 1) sapogenins mostly belong to β-amyrin group. Saponin, when boiled in alcohol under reflux with 2% to 5% of hydrochloric or sulphuric acid, undergoes hydrolysis. In other words, the compound is broken down into sapogenin and sugar parts (moieties), characterisation of which identifies saponin with either of the above mentioned groups. Sometimes, hydrolysis of a saponin is effected with enzymes, e.g., alfalfa saponin undergoes hydrolysis with a fungus (*Aspergillus*) preparation. Glucose, galactose, glucoronic acids, xylose, arabinose, fucose and rhamnose are the eight most common sugars present in saponins. Generally several sugar units linked with each other in a straight or branched chain are attached to a sapogenin to form a particular saponin (Fig. 1).

There are quite a few plants which are well-known as sources of saponin (Table 1).

The saponin containing plant material when shaken in powder from with water forms a persistent lather at the top of the water layer. The more the saponin content, the more persistent and voluminous would be the lather. The saponin is always a mixture of complex glycosides and hygroscopic amorphous powder. Single crystalline saponin is rarely encountered. One of the exceptions is saponin from *Putranjiva roxburghii*.

## Separation and isolation

The saponin containing plant material is powdered and repeatedly percolated with alcohol or extracted in a soxhlet apparatus. The total extract, after the removal of solvent by distillation, is freed of hexane and other soluble substances. The resultant alcoholic concentrate is then filtered and is added dropwise into a large excess of ether or acetone. The precipitated saponin settles at the bottom of the container and the clear ethereal solution is decanted off. The saponin on warming and evacuation gives a foam which can be further purified by repeating the process of precipitation. In case of tannin or chlorophyll-rich plant material, the above process of separation and isolation is to be modified suitably. The separation of individual saponins or the complex glycosides is effected by chromatography on cellulose, silicagel, or ion-exchange resin columns using suitable mixture(s) of solvents like chloroform, methyl alcohol, acetic acid, ethylacetate, butyl alcohol, pyridine, tetrahydrofuran and water.

Saponins possess emulsifying properties in general. They lower surface tension and tend to alter permeability of the cell wall and hence produce a general toxicity in all types of tissues. In very dilute solutions saponins produce haemolysis of blood. They also possess antilipemic, anticoagulant, anti-proteolytic properties and capacity to lower serum cholesterol levels. A saponin from alfalfa is reported as a respiratory inhibitor. Some saponins have already been tried as insecticides and they can safely be used in the form of dusting powder, emulsion or solution, since they are nontoxic to human beings and animals. Some of them have good anthelminitic property. It is reported that termiticidal action of saponins is responsible for the termite resistance of wood of *Kalopanax*. The foaming and detergent action of saponins has been responsible for the age old use of several plant parts for cleaning hair and woollen clothes. Due to their wetting power, saponins find use in photo film manufacture and also have been utilized in making emulsion stabilizers as they reduce surface tension. They match well with gum arabic in their use as protective colloids in spray drying of powdered flavouring materials.

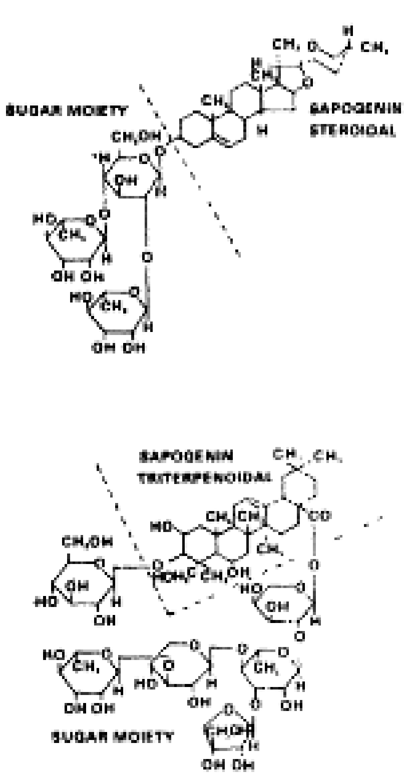

**Fig. 1. Structure of saponins**

**Table 1: Some saponin yielding plants**

| *Popular name* | *Latin name* | *Plant part* | *Type of saponin* |
|---|---|---|---|
| 1. Alfalfa | *Medicago sativa* | Whole plant | Triterpenoidal |
| 2. Beet Root | *Beta vulgaris* | Do | Do |
| 3. Dioscorea | *Dioscorea deltoidea* | Tuber | Steroidal |
| 4. Horse chestnut | *Aesculus indicus* | Seed | Triterpenoidal |
| 5. Liquorice | *Glycyrrhiza glabra* | Root | Do |
| 6. Mahua | *Madhuca indica* | Seed | Do |
| 7. Shikakai | *Acacia concinna* | Pods | Do |
| 8. Soapnut | *Sapindus mukerossi* | Fruit coat | Do |
| 9. Soybean | *Soja hispida* | Seed | Do |
| 10. — | *Hedera helix* | Seed | Do |

They are also used in beverages to produce a frothy effect.

Saponins also have several important medicinal properties. Asiaticoside, a saponin obtained from *Centella asiatica* (Hindi: *Brahmi booti*), is reported to have curative effect against leprosy, while another saponin, glycyrrhizin obtained from licorice (Hindi: *Mulhatti*) is used in the treatment of gastric ulcer and dermatitis. Glycyrrhizin is also a sweetening agent as ammoniated glycyrrhizin is 50 or 100 times sweeter than ordinary sugar. Its anti-inflammatory effects have been established.

The dried leaves of foxglove (*Digitalis purpurea*) are used in tablet form to strengthen a weakened heart. The therapeutic activity of the leaves is due to the steroidal cardiotonic glycoside, digitoxin. The tubers of various species of *Dioscorea* the yam plants are the main source of diosgenin which forms the starting material for the manufacture of hormones such as progesterone, hydrocortisone, androgens (male sex hormones), oestrogens, progestogens (female sex hormones) and oral contraceptive, the 'pill'.

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# Saline alkali soils

SALINE alkali soils are a problem that involves 7 million hectares in India. They occur mainly in the Indo-Gangetic plains, in arid and semiarid areas of Rajasthan and Gujarat, in arid and semiarid regions of black cotton soil group and in coastal saline areas.

Alkalinity occurs in soils when there is a high degree of base saturation. The presence of salts, especially calcium, magnesium and sodium carbonate, gives preponderance of OH ions over H ions in the soil. Salts of strong bases and weak acids, such as $Na_2 CO_3$, $K_2CO_3$ and $MgCO_3$ on hydrolysis develop alkalinity:

$$2\,Na^{+} + CO_3^{--} + 2HCH \rightarrow$$
$$2Na^{+} + 2OH^{-} + H_2CO_3$$

Since the dissociation of NaCH is greater than that of the week $H_2CO_3$, a domination of $OH^-$ ions results. Under such conditions, soil becomes alkaline and sometimes very strongly so. If sodium carbonate is present, a pH of 9 or 10 is not uncommon.

## Sources of soluble salts

The soluble salts in soils consist mostly of various proportions of the cations of sodium, calcium, magnesium and the anions chloride and sulphate. Cations of potassium and the anions bicarbonate, carbonate and nitrate occur only in minor amounts. Bicarbonate ions are formed as a result of the solution of carbon dioxide in water. The $CO_2$ may be atmospheric or biological in origin. Carbonate and bicarbonate ions are interrelated, the relative amounts of each present is a function of the pH of the solution. Appreciable amounts of carbonate ions can be present at pH values about 9.0

## Salinization of soils

In arid regions, leaching and transporation of soluble salts to the ocean is not so complete as in humid regions. Leaching is usually local in nature and soluble salts may not be transported far. This occurs not only because there is less rainfall available to leach and transport the salts but also because of high evaporation rates characteristic of arid climates, which tends to concentrte further salts in soil and in surface waters. Restricted drainage is a factor that usually contributes to salinization of soil and may involve the presence of high groundwater of soil.

## Alkalization

Alkalization refers to the accumulation of exchangeable sodium in soils. Soil particles absorb and retain cations on their surfaces due to the electrical charges of the soil particles.

Calcium and magnesium are the principal cations found in the soil solution and on the exchange complex of normal soils in arid regions. When excess soluble salts accumulate in these soils, sodium frequently becomes the dominant cation in the soil solution. Sodium may be the predominant cation to which the soil has been subjected or it may become dominant in the soil solution owing to the precipitation of $Ca^{++}$ and $Mg^{++}$ compounds. As the soil solution becomes concentrated through evaporation or water absorption by plants, solubility limits of calcium sulphate, calcium carbonate and magnesium carbonate are often exceeded and they are precipitated with a corresponding increase in the relative proportion of sodium. Under such conditions, a part of original exchangeable calcium and magnesium is replaced by sodium.

## Characterization of salt affected soils

These problem soils have been grouped into (i) saline, (ii) saline-alkali, and (iii) non-saline alkali soils.

(i) *Saline soil* : It contains a concentration of neutral soluble salts and only a small amount of exchangeable sodium. Such soils are sometimes called *White alkali* soils because they form a white surface incrustation and they are light in colour. The excess soluble salts which are mostly chlorides and sulphates of sodium, calcium and magnesium can readily be leached out of these soils with no appreciable rise in pH. This is a very important criterian in the management of these soils.

(ii) *Saline-alkali soil* : It is also known as saline-sodic soils due to the presence of appreciable quantities of neutral soluble salts and enough adsorbed sodium ions. Their pH is likely to be below 8.5. This is because of repressive influence of the neutral soluble salts as in the saline soils. These soils are formed as a result of the combined processes of salinization and alkalization. As long as excess salts are present, the appearance and properties of these soils are generally similar to those of saline soils. If the excess soluble salts are leached downward, properties of these soils change markedly and become similar to those of nonsaline-alkali soils. Upon leaching, the soil may become strongly alkaline (pH above 8.5.). The particles disperse and the soil becomes unfavourable for entry and movement of water and tillage (Fig. 1a).

(iii) *Nonsaline-alkali (sodic) soil* : These soils do not contain large amounts of neutral soluble salts. The exchangeable sodium is more than 15 per cent of the total exchangeable capacity of these soils. The pH range is between 8.5 to 10. Due to deflocculating influence of sodium, such soils are usually in an unsatisfactory physical condition. Because of the extreme alkalinity resulting from the sodium carbonate present, the surface of alkali soils is usually discoloured by the dispersed humus carried upward by the capillary water, hence, the name black alkali soil. These soils are often located in small areas called slick spots surrounded by soils that are relatively productive. The high pH is largely due to the hydrolysis of sodium carbonate.

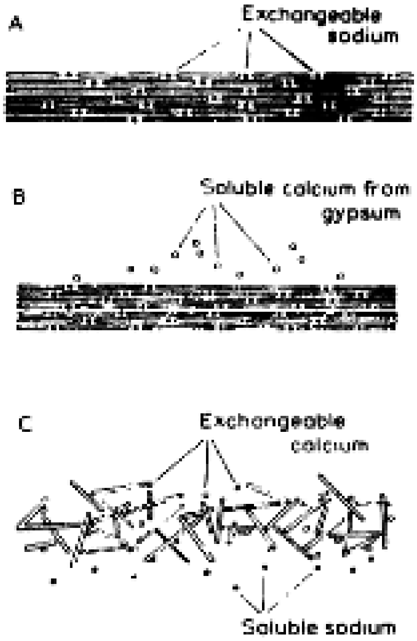

**Fig. 1 (a). Excess sodium results in destruction of soil aggregates and tight packing of fine soil particles. This restricts water and air movement and root growth; (b) Soluble calcium from amendment dissolves in soil solution and is available to replace absorbed sodium; (c) Replacement of sodium by calcium results in improved soil structure and in turn better water and air movement through soils. The sodium salt must be leached out of the root zone** *(Courtesy* : **I. P. Abrol and F. Fireman)**

## Salt affected soils and plant growth

Saline and saline-alkali soils with their relatively low pH and high soluble salt concentration detrimentally affect plant growths, largely due to plasmolytic effect.

Sodic soils dominated by active sodium affect plants in three ways : either by the caustic influence of the high alkalinity caused by sodium carbonate and bicarbonate, or by toxicity of bicarbonate and other anions, or by the adverse effect of the active sodium ions on plant metabolism and nutrition.

## Management of saline and sodic soils

Ordinarily there are three ways in which saline and alkali soils can be managed in order to avoid, atleast partially, the injurious effect to plants. These are eradication, conversion of some of the salts of less injurious forms and control.

Leaching with water is the only practical way to remove excess salts from these saline soils. The salts must pass below the root zone and be discharged from the area by underground seepage or through nallas or artificially through man-made drainage systems. Leaching may be done most efficiently by ponding water in fields.

Basically, reclamation of an alkali soil requires removal of the exchangeable sodium and its replacement by calcium (Fig. 1, b and c). This is normally done by suitable soil amendments like application of gypsum followed by leaching. The sodium sulphate formed is leached out by irrigation. Other amendments which can be used are the application of rock phosphate, calcium chloride, phosphogypsum, basic slag, sulphuric acid, sulphur, iron pyrites, and aluminium sulphate etc.

The retardation of evaporation coupled with judicious irrigation and application of FYM and green manure is of course an important criterion in the control of salty soils. This will arrest the upward movement of the soluble salts in the root zone. The use of salt resistant crop varieties is also a profitable approach. Crops like, paddy, sugarbeets, cotton, barley and alfalfa are often recommended for these areas.

The area under salt affected land is increasing at a fast rate with the introduction of irrigation projects coupled with poor water management especially in arid and semiarid regions. Such lands often lie barren and when cultivated, crops either fail altogether or give very poor yield.

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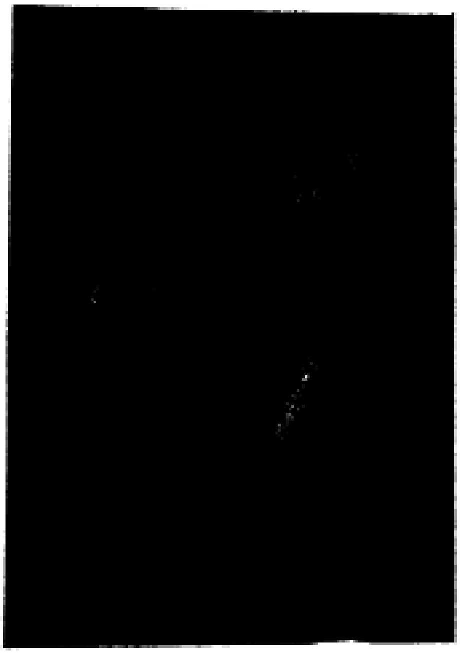
# Quarrying — a hazard to hill vegetation

MUSSOORIE hills today face a serious threat from heavy limestone quarrying. One of the important national summer tourist resorts, Mussoorie deserves protection from destruction since beauty of her hills embodifies the temperate and subalpine vegetation. These forests may face extinction in near future due to indiscriminate blasting for limestone and marble in areas around Mussoorie, viz., near Bhatta toll barrier, on the east of Jharipani, north of Rajpur and all around Sahastradhara. Quarrying in these areas should be immediately checked to avoid heavy rockslides which ultimately destroy hills and forests.

Another important factor that leads to denudation of forests is chopping down of trees. Attempts to restrict these activities are being made locally through the 'Chipko Andolan'. This movement was started in 1972 at Gopeshwar when Simon and Company, a British concern based in Allahabad, was assigned contracts in this area. Hugging of the trees is done by volunteers of chipko andolan so as not to allow contractors to cut them. This movement has since spread to all parts of Kumaon and Garhwal hills.



Lime stone quarries, east of Jharipani River near Rispana

Studies have shown that the destruction of forests leads to more accumulation of carbon dioxide. Rainfall has also been observed to decrease. The natural ecological balance is thus disturbed affecting the flora and accessibility of the tourist spots.

In a recently organized all India Symposium on the Vegetational Wealth of Himalayas, at the University of Garhwal, Srinagar (U.P.) i the first week of October, 1979, the importance of forest conservation was highlighted. Some botanists recommended plantation of trees on bare hills. However, before switching over to this project, the present system of quarrying through blasts should be changed over to tunnelling which would have no direct impact on the existing vegetation.

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# Synthetic pyrethroids

PYRETHRIN, a natural product obtained from the flowers of pyrethrum (*Chrysanthemum cinirariefolium* Vis.), is known to be a very effective insecticide. In spite of its low mammalian toxicity and fast rate of biodegradation, pyrethrin did not find widespread usage because of its relatively high cost and inadequate supply. But recently a number of chemicals have become available, which not only carry the biologically active structures of the natural product but are also cheaper than the natural substance. This group of chemicals is known as synthetic pyrethroids.

Three of the synthetic pyrethroids —fenvalerate, cypermethrin and permethrin—are currently being tested in India as agricultural pesticides. Preliminary trials have shown them to be far superior to conventional synthetic insecticides (organochlorides, organophosphates and carbamates), even at application rates of only 1/50 to 1/10 of normally recommended rates of the conventional insecticides. Table 1 gives the insecticidal activity and yield of seed-cotton as observed in a trial in which permethrin was compared with carbaryl. Carbaryl is a carbamate insecticide recommended specifically for control of bollworm in cotton.

An extensive review written by three British authors M. Elliott, N. F. Janes and C. Potter of Rothamstead Experimental Station, U.K., gives information about the physico-chemical and biological properties of synthetic pyrethroide (*Annual Rev. Entomol.* 23, 443-469, 1978). Most of them are viscous, lipophilic liquids, having a high boiling point and low volatility. They are practically insoluble in water.

Although most of them are photolabile, there are a few, like the ones mentioned above, that are highly photostable. The photostable pyrethroids are the ones that are useful as agricultural insecticides, while the photolabile ones can be recommended only for indoor use. No pyrethroids are sufficient volatile to be used as fumigants, but some of the more volatile ones are recommended for use in mosquito coils.

Pyrethroids act as nerve poisons and not via acetylcholine, as in case of organophosphates. The low mammalian and avian toxicity of the pyrethroids is exhibited mainly when they are administered as contact or stomach poisons. If administered intravenously, they show a fairly high toxicity to mammals and birds too, but in normal usage there is practically no danger of these chemicals entering directly into the blood stream of animals or humans. Insects, on the other hand, have nerve endings at the tips of their legs and also at various other points of their body, so that when they come in contact with a surface sprayed with pyrethroids, they are instantaneously paralysed. This peculiar mode of action is technically called 'knock-down effect'.

Since pyrethroids have not been in use for long, there are very few reports about insects developing resistance against them. There are, however, reports from Denmark and Sweden that houseflies that had already developed resistance to D.D.T. were found to be resistant to pyrethroids too. The chemical nature of the two compounds being quite different, the basis of this resistance is assumed to be the development of some sort of a mechanical barrier which inhibits the penetration or binding of the insecticide. The resistance was however found to be controlled by a recessive gene, so that only the recessive, homozygous flies showed resistance. If similar resistance develops in other insects too, it would be necessary to devise insecticidal schedules in such a way that natural selection and increase of the frequency of the resistance gene in the insect population is avoided.

**Table 1 Parameters of bollworm injury and seedcotton yield in an insecticidal trial containing permethrin and carbaryl (mean of three trials conducted at Phaltan from 1977 to 1979)**

| *Treatment* | *Dosage per application* | *Mature bolls per plant* | *% bolls with bollworm injury* | *Seedcotton kg/ha* |
|---|---|---|---|---|
| Permethrin | 125 g/ha | 22.96 | 11.68 | 4365 |
| Carbaryl | 1250 g/ha | 15.32 | 28.82 | 3216 |
| Untreated control | — | 12.48 | 49.85 | 2307 |

In spite of their high insecticidal activity and low mammalian toxicity, pyrethroids cannot be used in anti-malaria sprays and in paddy fields, because of their high toxicity to fish. The lipophilic nature of the pyrethroids enhances their selective absorption by aquatic animals, even when their concentration in water is quite low. In the case of fish, pyrethroids can enter the blood stream directly through gills. They are however safe for use on most of the agricultural crops, because they are readily absorbed by the waxy layers of plant epidermis and immobilized to a certain extent. Pyrethroids do not enter into the plant cell as readily as organophosphatic or carbamate insecticides, but if they do, they are readily metabolized and converted into harmless products. Even soil microorganisms readily degrade pyrethroids, so that the materal falling on the soil while spraying, or washed off the plants by rain, is degraded before it can reach a stream, river or lake.

Some of the other possible uses of pyrethroids are, apart from agricultural pesticides, indoor uses in households, hotels, bakeries, museums, animal stalls, etc. ; impregnation of wood, woollen clothes, upholstery, carpets and rugs; direct use on mammals and birds for the control of lice, ticks and fleas; interior spraying of aeroplanes, railway coaches and ships; seed treatment and treatment of stored grains.

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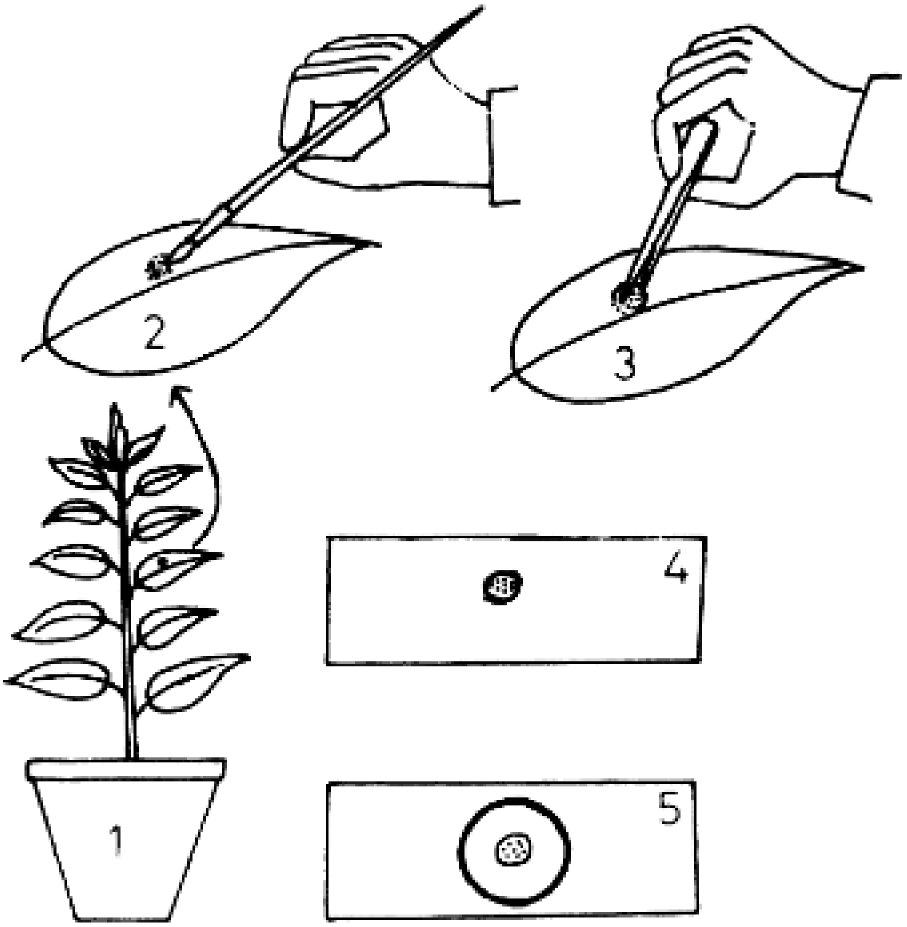
# Fevicol technique in stomatal studies

THE type, size and distribution of stomata are of utmost importance in genetics and systematics. The most common technique on stomatal mounting for morphological and taxonomical studies is the peeling method, which is employed on fresh, dried and fixed materials. The preparations of epidermal peels for such a study differ widely (Clarke, 1960; Ahmad, 1964; Stace, 1965; Boulos and Beakbane, 1971; Inamdar, *et al.*, 1971; and Raghuvanshi and Singh (1972). But the preparations for the purpose are to be made generally in the laboratory as it is inconvenient to do so in the fields; more so when large number of samples are to be tried for comparison. Added to this limitation, the peeling is not possible universally in all the



**Figs. 1-5. Schematic diagrams showing fevicol technique**

plants and the peels thus obtained cannot be stored for a longer period for examinations and analysis.

### Fevicol technique

In the proposed technique, fevicol, which is a common commercial gum (synthetic resin), is applied to the stomatal surface of the leaves, bracts, young stems and fruits in the field itself, with the help of a brush. This thin uniform coating is allowed to dry for 3 minutes -4 minutes. In case of dry or herbarium material, which is to be used for this purpose, is dipped in hot water for sometime and water is blotted out followed by the application of fevicol. After 3 minutes - 4 minutes of drying, the fevicol coating is peeled out very gently using forceps and the peel is spread on the slide followed by placing the coverslip on it. Tap the preparation gently with back of the pencil and seal the coverslip all round with fevicol itself before using the preparation for microscopic examination and microphotographs. Figs. 1-10 illustrate the mode of such a preparation. The entire preparation takes hardly 10 minutes and such preparations are not affected by either high or low temperature. The preparations can be preserved for any length of time for use.

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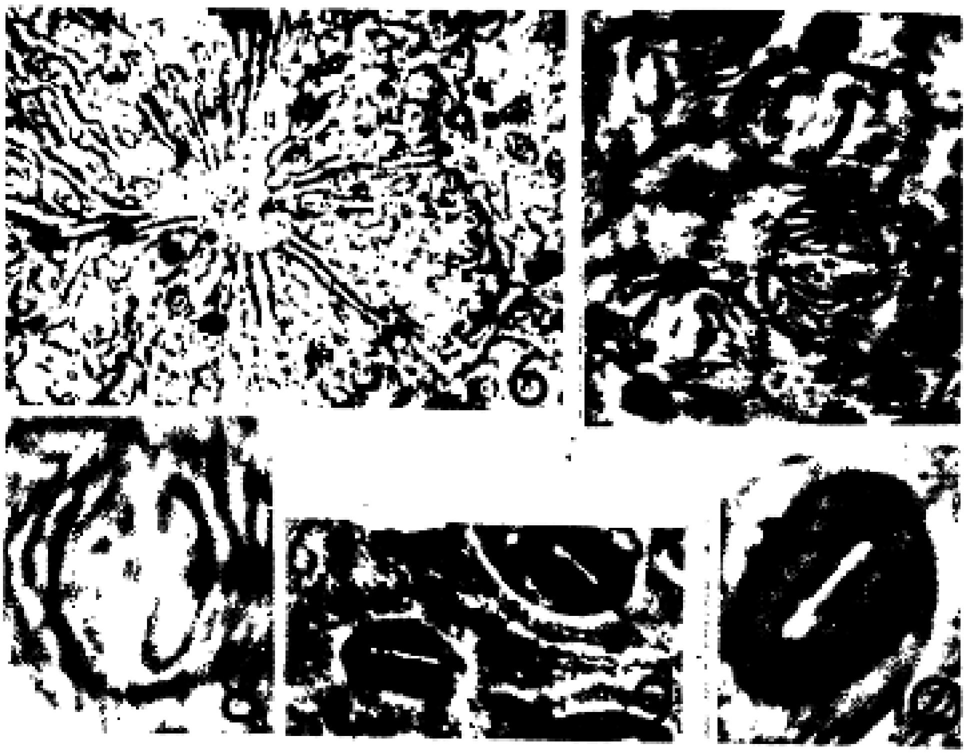

**Figs. 6-10. Microphotographs taken from fevicol preparations**

# The uropygial gland of birds

THERE is a unique subcutaneous organ situated on the rump region at the base of the tail feathers of birds, the exact function of which still remains to be known. This bipartite structure is variously called the uropygial or preen or oil gland. Though well developed in flying and aquatic birds, it is absent in the non-flying birds (namely, Struthioformes, Rheiformes, Casuariformes). Literature indicates that this gland received attention of the biologists in as early as the 18th century, but it was H. C. Hou in the year 1928 (*Chinese J. Physiol.*, **2**: 45-380) who really made some significant progress in understanding some of its physiological functions. He observed that if the uropygial gland was experimentally removed from the bird, feathers became disorderly arranged and hydrophilic. Inspired by these findings, he made further observations on the experimentally ablated birds which showed metabolic disorders characterized by loss of body temperature, reduction of body weight, development of rickets and depletion of the plumage cholesterol. Extensive histological and histochemical studies have since been carried out, particularly in the last two decades. This made it possible to learn a great deal about this peculiar gland in birds, especially its marked similarity with the mammalian sebaceous gland (because of the holocrine release of the oily secretion and also for the regulation of its functioning by the gonadal hormones, particularly androgens).

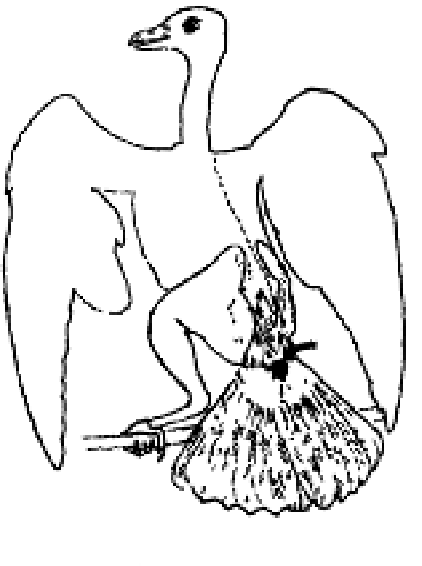

**Fig. 1. Location of the uropygial gland**

## Embryology and gross anatomy

Paired invaginations of the embryonic epidermis of the lower rump region appear on the 8th day of incubation in common pigeons, 9th to 10th days in chicken and the 10th day in pekin ducks. The epidermis sinks inward and gives rise to solid buds of cells which become covered by dermal connective tissue. The buds then subdivide and form a lumen, subsequently forming tubules around a central cavity. A papilla develops and secretion droplets begin to appear in the tubules a few days before hatching.

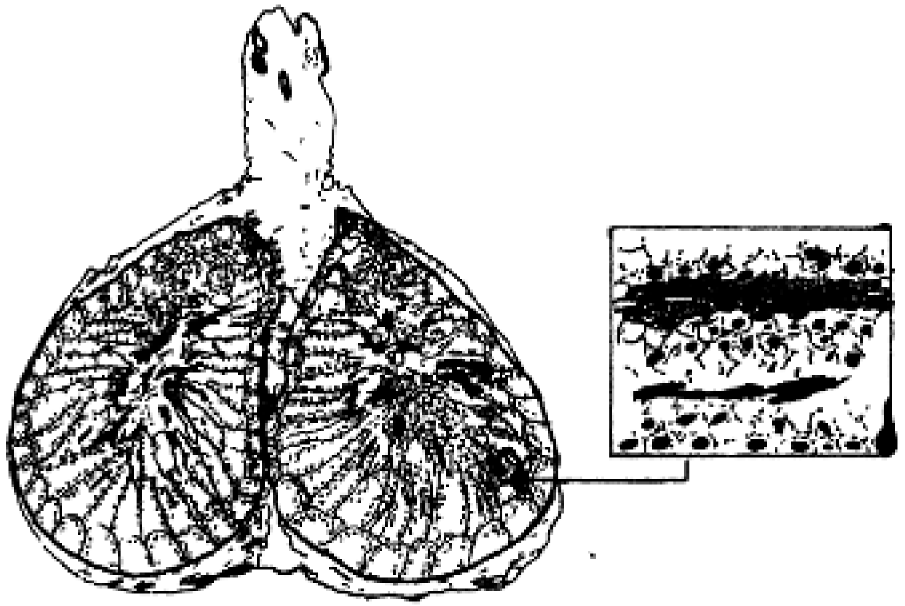

**Fig. 2. Sectional view of the entire gland with alveoli and nipple; part of an alveolus has been enlarged to show the cell types and the secretory materials**

A fully formed gland is a bipartite structure and the two lobes are always joined at their caudal end by a band of tissue—isthmus. It is enclosed in a capsule of connective tissue and sometimes embedded in fat. Smooth muscles have been observed mostly near the caudal end but they do not ensheath the gland. The gland has a weight of about 0.06% to 0.07% of the body weight and is of variable shapes and sizes depending upon the species of bird it belongs to. It is situated dorsally at the base of the tail (Fig. 1) and opening on to the surface of the skin by a nipple-like projection (Fig. 2). The total number of orifices varies among birds from one in the Hoopae (*Upupa epops*) to 18 in the Pelican (*Pelecanus* sp.). The skin over the gland may be bare or feathered but the papilla is generally bare except at the tip, where there is commonly a tuft of down feather—the uropygial wick. The location of the gland is concealed by the body feathers except when a bird exposes it in preening.

The gland is vascularized by the caudal artery and the caudal vein and it is innervated by the 1st pair of caudospinal nerve and by sympathetic fibres. It is thought that stimulation of the sympathetic fibres causes dilatation of sphincter muscles around the external opening of the ducts.

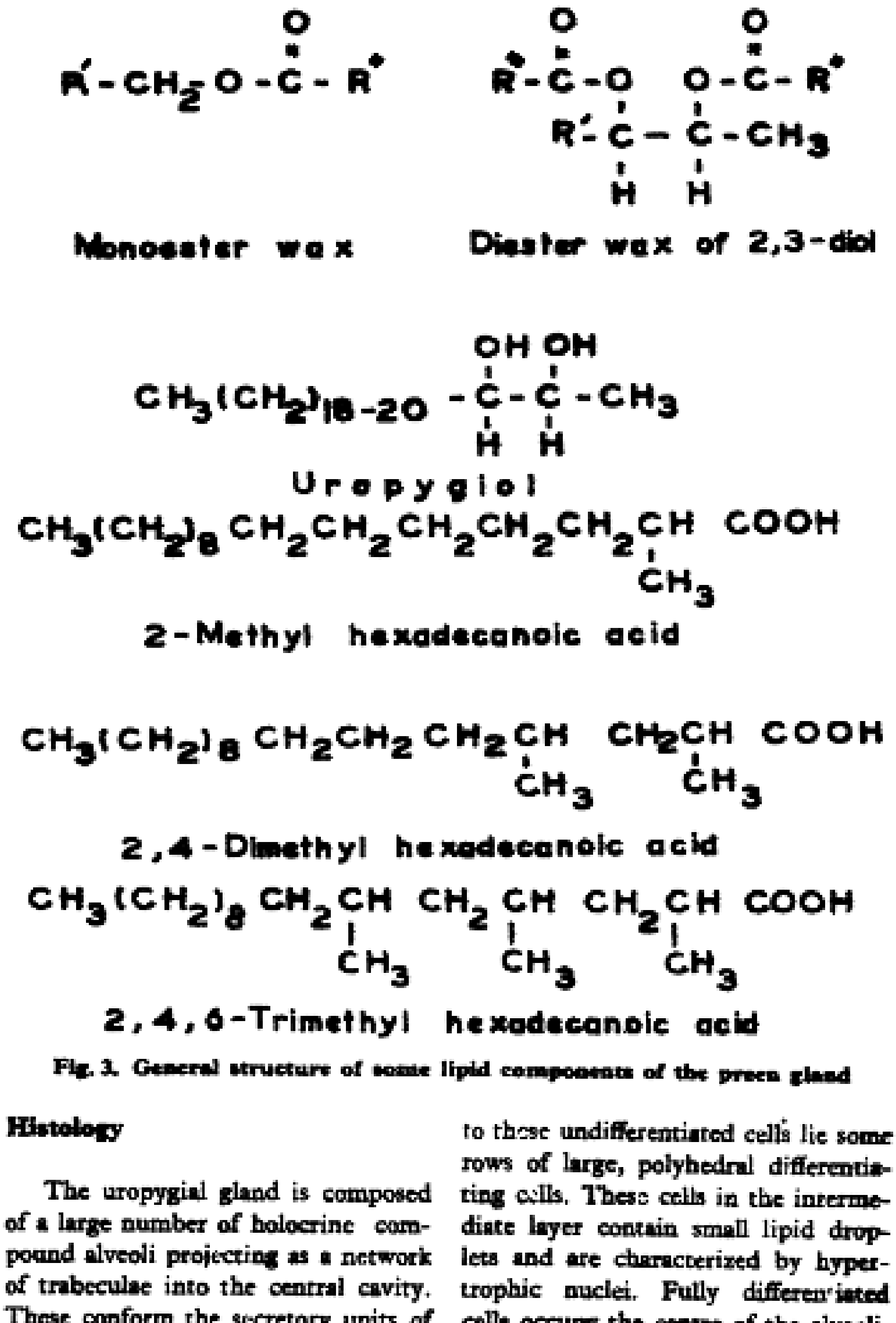
Monoester wax
Diester wax of 2,3-diol
Uropygiol
2-Methyl hexadecanoic acid
2,4-Dimethyl hexadecanoic acid
2,4,6-Trimethyl hexadecanoic acid

Fig. 3. General structure of some lipid components of the preen gland

**Histology**

The uropygial gland is composed of a large number of holocrine compound alveoli projecting as a network of trabeculae into the central cavity. These conform the secretory units of the gland. Alveoli of the uropygial gland resemble that of the sebaceous gland (more particularly the preputial gland of rodents) in the gross microscopic features and cellular make-up. Four types of cells have been described in the secretory acinus (Fig. 2). A single ply of flattened cells having a high potency of division occupy the basal region of the alveoli. Inner to these undifferentiated cells lie some rows of large, polyhedral differentiating cells. These cells in the intermediate layer contain small lipid droplets and are characterized by hypertrophic nuclei. Fully differentiated cells occupy the centre of the alveoli. Cytoplasm of these cells is full of lipid materials. Cells at the border of the aciner lumen show disintegration.

**Histochemical composition of the secretion**

Although the composition of secretion varies among species, approximately half of the secretion has been found to be ether soluble. E. Haahti and coworkers at the Department of Medical Chemistry, and at the Department of Zoology, University of Turku, Finland in 1964 analyzed the composition in 14 species of birds and found that the lipids in most cases were mainly aliphatic waxes, but in three galliform species they were esters of dihydric alcohols with fatty acid. Cholesterol esters, triglycerides and phospholipids were the other lipid materials found. According to J. Jacob of the Biochemisches Institut für Umweltcarcinogene, Ahrenburg, Holstein, West Germany (1975), hydrolysis of the uropygial gland wax yields generally more than one type of fatty acids. While most of the tissues contain generally fatty acids with even C-numbers ($C_{14}$—$C_{18}$), the same in the uropygial gland secretion contain long, straight chain, even-C fatty acids; fatty acids with odd-C numbers and single or multiple branched fatty acids (2-, 4-monomethyl; 2, 4- or 2, 6- or 2, 8-dimethyl; 2, 4, 6-trimethyl; 2, 4, 6, 8-tetramethyl; 2, 4, 6, 8, 10-pentamethyl) are also present besides the usual ones (Fig. 3).

S. P. Bhattacharyya of the Department of Zoology, Kalyani University, West Bengal, in his comparative study (1972) on the histochemical components of the preen gland in ten species of Indian birds noted a gross similarity in the distribution of histochemical components in them. Of the total lipid materials (26%-45% of the gland weight), which constituted the bulk of the secretion, triglycerides, phospholipids and acidic lipids were the main components. Percentage of total fatty acids and non-saponifiable matter showed wide range of variation. Cholesterol was present in significantly low amount.

J. Jacob and G. Grimmer of West Germany in 1975 observed that only 6.7% of the whole plumage lipids of the ring dove originates from diester waxes of the preen gland secretion. The rest is distributed to hydrocarbons (3.3%), sterol esters and waxes

(10.7%), free alcohols and sterols (5%), free fatty acids (55.6%) and unidentified materials (18.7%)

Several proteins, inorganic compounds, polysaccharides, ascorbic acid, alkaline and acid phosphatases are among the other materials detected in the secretion of many species of birds. Iron has also been reported in a few birds.

K. Ishida and his colleagues at the Department of Animal Husbandry, Niigata University, Niigata, Japan in 1973 demonstrated the activity of several dehydrogenase enzymes in the uropygial gland of fowl.

## Recent experimental works on uropygial gland

B. R. Maity of the Department of Zoology, Calcutta University, Calcutta, observed in 1969 that the uropygial gland exhibited atrophic manifestation with the onset of non-breeding season followed by a hypertrophic picture during the breeding phase in house-sparrow, *Passer domesticus*. He therefore attributed a probable role to the testicular and adrenal androgen in the control of secretory cycle of the uropygial gland. Later, in 1971, the same author showed that administration of estradiol in intact adult male pigeons elucidated a regression of the uropygial gland. Parallel treatment of estradiol in female birds provoked a stimulation of this gland. It has been suggested that estrogen is not normally involved in the maintenance of the preen gland of female pigeons and androgen and/or adrenocortical hormones replace estrogen in regulating the uropygial gland of females. In the following year, Maity further noticed that progesterone treatment in adult castrated pigeons failed to stop the cytological atrophy which resulted from castration. In fact, it aggravated the situation, mainly by increasing the rate of cell loss in the gland. He therefore suggests that progesterone cannot stimulate the uropygial gland. In 1972, Maity along with A. Ghosh of the same Department, also observed that vitamin-C deficiency induced glandular regression presumably by suppressing androgen and/or other hormonal production in red-vented bulbul, *Pycnonotus cafer*. Recently, S. P. Bhattacharyya and M. Chowdhury of the Department of Zoology, Kalyani University (1978) studied the effects of androgen on the composition of lipid materials of the preen glands of juvenile and adult pigeons. Interestingly enough, it was observed that the glands of juvenile intact and castrated pigeons were smaller in size than those of the adult controls. Testosterone therapy in castrates restored the gland weight to normal and increased the percentage of total lipids and cholesterols. Administration of testosterone to adult males induced a moderate rise in the level of total lipids and neutral fat. In the glands of all the experimental pigeons, a decrease in the content of free fatty acids was observed. According to these authors, the smaller size of the preen gland in the juvenile pigeons in relation to that in adults, the apparent atrophy in prepubertally castrated pigeons, as well as restoration of the gland following testosterone treatment in castrate indicated the positive effect of androgen on the maintenance of the preen gland in the pigeon.

## Possible hormonal regulation of uropygial gland

Though our knowledge at present is not very adequate, it is generally believed that the structure and secretory activity of this gland are largely influenced by endocrine factors, especially the androgens. Estrogens, on the other hand, may not have much involvement in the maintenance of the uropygial gland although the influence of this hormone on this gland is not yet fully understood. A direct role of the adrenals has not also been envisaged. Conversely, a possible involvement of glucocorticoids in the regulation of the gland has been suggested. It is interesting to note that the response of the uropygial gland to male and female sex hormones is identical to that of the sebaceous gland, but the role of other extra-gonadal hormones on its functioning remains to be known.

## Functions of the gland

The exact functions of the preen gland are not yet definitely known. The present state of our knowledge would only permit us to say that this gland seems to be related with the preening of feathers. It is thought that the waxy materials of the secretion help maintain a hydrophobic coating around the body of the birds. It is likely that the other components of the secretion may somehow be associated with chemical communication or may be used in the self-sterilization of the skin by preventing the growth of cutaneous microbial pathogens or they may serve the functions of an accessory steroid producing organ. Only further research in this direction can confirm or refute.

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# The beautiful spider Argiope

SOME of the most beautiful spiders found in India belong to the genus Argiope of the Family *Argiopidae* (=*Araneidae*). Nearly

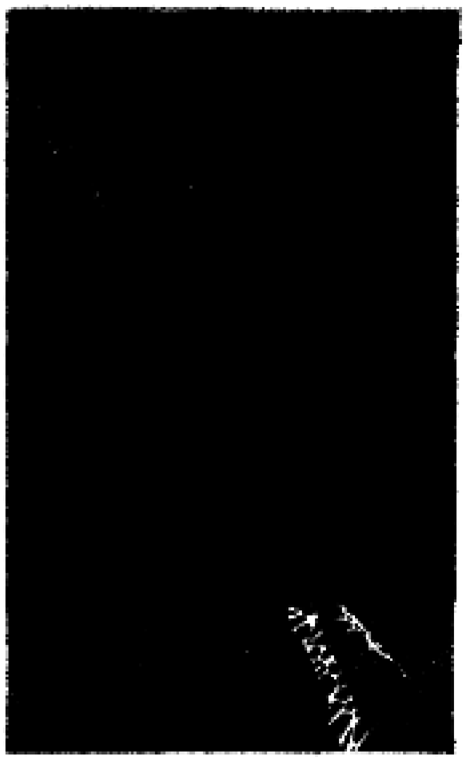
100 species of this genus are widely distributed in the world but only eight species have been identified from India.

The Argiope spiders are beautiful and large. In some species the females reach upto 25 mm in length; males are much smaller. *Argiope pulchella* (Fig. 1) is quite conspicuous with yellow-olive back and intricate design on the cephalothorax.

One of the characteristic feature of this genus is the presence of ribbons of conspicuous white silk in the middle of their web (Fig. 1). The ribbons are scientifically known as stabilimenta. They are tightly packed zigzags of silk. Hundreds of silk threads make this ribbon, like the fibres in a rope. In a web, the ribbons often cross each other (closed stabilimenta) like the word X (Fig. 2), but in most cases, especially in adults, the centre of the web is devoid of such structure (open stabilimenta). Here the four arms of the stabilimentum remain separated from each other as shown in Fig. 1. The males and very small spiderlings do not build such structure.

The shape of the stabilimentum differs in different species, in webs of different individuals of the same species, and also, in different webs of the same individual. The perfect stabilimentum is in the shape of a cross, with four arms and a gap in the hub (centre). Variations are common. Some stabilimenta have only three arms, still others have only two or one arm. Sometimes only the upper two arms are present, while in others only the lower ones can be seen. In yet other webs, only the upper and lower arms of right side are present. After studying two specier (*A. pulchella* and *A. aemula*) of this genus for three months, the author has found twelve types of stabilimenta on the basis of only the position of the arms. If the size of the arms is also taken into consideration then the categories of the stabilimentum are considerably increased. Juvenile Argiope build a disc-shaped stabilimenta covering a greater part of the hub.

Many functions have been ascribed to the stabilimentum. Some scientists believe that it acts as a defence against predators because a spider sitting at the hub with four large arms of white silk-web looks larger, and thus more fearful. Another suggestion is that the stabilimentum acts either to attract small insects or to divert large insects away from the web to prevent them from damaging it (Ewer, *Jour. Nat. Hist.*, 6: 159-167, 1972). It is believed that the spider builds, different types of stabilimenta to confuse the predator who might learn to correlate the presence of a spider (food) with any standardized design of the stabilimentum. Yet another scientist has suggested that the stabilimentum acts as a sunshield and protects the spider from direct sun rays. The author does not agree with this view because in many webs studied, the spiders always remained on the side facing the sun. If the role of the stabilimentum is to function as a sunshield then the spider should move behind it when exposed to the sun. Moreover, stabilimenta are equally common to the webs which are in shade as well as to those exposed to direct sun.



A female *Argiope aemula* (Walckenaer) sitting in the centre of the web (Photo by Saeed Ahmad)

Fig. 1. Female *Argiope pulchella* Thorell with open stabilimentum Photo by Saeed Ahmad)

Barbara C. Robinson and M. H. Robinson, of the Smithsonian Tropical Research Institute, Panama, USA,

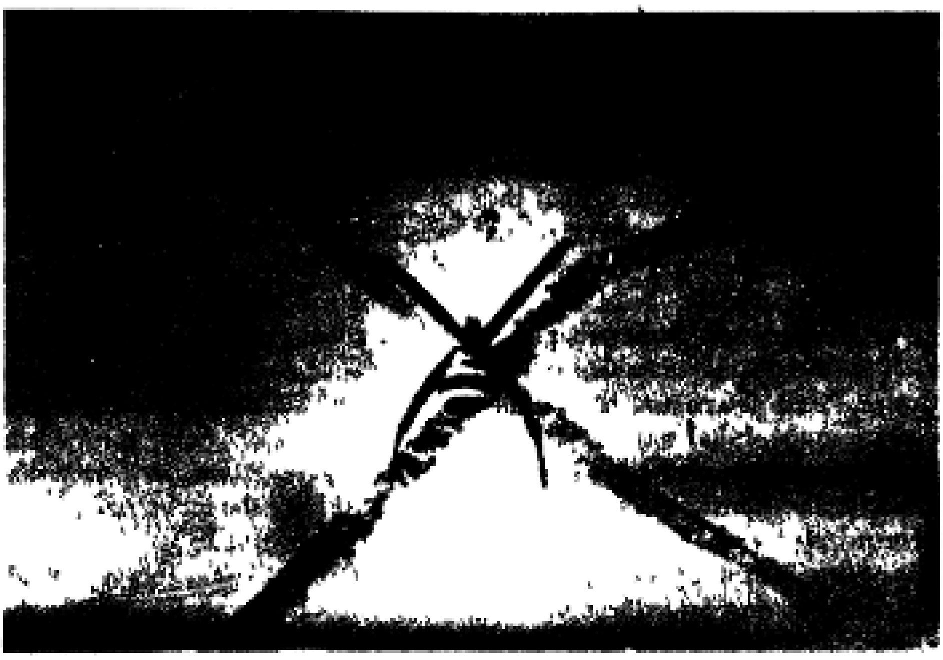


**Fig. 2. Female *Argiope pulchella* Thorell with closed stabilimentum (Photo by Sadee Ahmad)**

who are presently working on this genus in Wau Ecology Institute, Papua, New Guinea, believe that the stabilimentum has a mechanical (bracing) function, but direct evidence for this view is lacking at present. Whatever may be the function of stabilimenta, it undoubtedly increases the attractiveness of the spider, atleast for man.

The life history of *A. aemula* (and other members of this genus) is interesting. The female is much larger and dominating among the two sexes. The small, diminutive male lurks around the web; after a ridiculous courtship dance, it has a quick mating, or better say, transferring of sperms, and runs away lest it is devoured by the ingrate female. The female spins a small cocoon or egg-case and deposits 200-300 eggs in it. The egg-case is normally hung near the web but the author did not find any parental behaviour. After 20-22 days, on a bright sunny day, spiderlings "hatch" out from one or two weak points in the eggcase. Most of the spiderlings clump together except for the few adventurous ones who run around the bushes. The spiderlings remain in this condition for 3-5 days and then scatter around one by one. Most of the spiderlings do not survive long. Ants often descend on the hapless spiderlings and catch many of them who venture out from their draglines.

Male spiderlings mature early, after eight or nine moults, while the females mature only after 13-14 moults. In the beginning, coloration of the two sexes is same. At the last moult, the male loses its silver coloration and becomes dull and inconspicuous (Robinson and Robinson, *Sym Zool. Soc., Lond*. No. 42: 31-40, 1978). Perhaps, the dull coloration helps the furtive male to camouflage from the agile female and other predators. The female Argiope matures slowly due to her greater instars and comparative long duration between final moults. So mating between siblings is unlikely.

One interesting behaviour shown by Argiope and many other spiders is "shamming dead". When the spider is touched or disturbed, it at once drops down as if dead It is also known as 'cataleptic reflex'. Shamming dead is best seen in *A. pulchella*, less so in *A. aemula*. Hunting and wandering spiders also show cataleptic reflex—they fold their legs over their cephalothorax and remain immobile. Helped by their inconspicuous colour, the spiders become unrecognizable and avoid predation.

*A. aemula* and *A pulchella* show another fascinating behaviour, viz., rocking of web when it is agitated. As soon as its web is touched, the spider "stands up" and starts rocking The whole web moves forward and backward, sometimes continuously for ten minutes But this rocking action is not observed when insects strike the web. Presumably, the spider uses its visual faculty to distinguish between disturbance caused by a trapped insect and disturbances by other agencies

Construction of the web is an elaborate process and it is always done late in the night, preferably before dawn. The abovementioned species of Argiope were never seen to make their webs during the day. Threads of the web are easily destroyed by a fluttering moth or a butterfly, the two chief food items of Argiops. Depending upon the condition, the web is changed daily. However, if the web is not broken, it may remain unchanged for 3-5 days. By staining the threads with Alizarine S (dissolved in glycerine) the author has found that the outer threads, also called as scaffoldings, by which the web hangs, are not changed frequently Sometimes, scaffoldings remain for 25 to 30 days while the inner web is changed every day or after two or three days.

*A. pulchella* builds its web comparatively in a high place than *A. aemula* which is mostly found in bushes. The web of *A. aemula* is also smaller. However, the shape and size of the web greatly depends upon the distance between two bushes (or branches) and on the anchoring points. The webs of both the species are vertical to the ground but sometimes they make a small angle.

Like any other typical spider, the food of Argiope spp. consist of insects, especially of the Order Lepidoptera When an insect is trapped in the web, the spider at once catches hold of

(*Continued on page 521*)

# India enters the Space Age

JULY 18, 1980 will go down in the history of India as a day the country entered the space age. The indigenous Satellite Launch Vehicle (SLV-3) was able to place the small Rohini satellite into an orbit of earth. Today, the satellite is orbiting the earth every ninety seven minutes telling the world that India is second to none in matters of developing sophisticated technology. More than a thousand scientists, engineers and technicians of various disciplines working in the various space centers of the Indian Space Research Organisation (ISRO), hundred of kilometers away from each other, combined their expertise with 46 major Indian industries scattered all over the country to make the launch of the satellite a perfect success.

The SLV-3 was a four stage rocket which had a height of 22 meters and was one meter in diameter at the base. It weighed 17 tonnes and was composed of 44 sub-systems. The solid propellant that drove the rocket weighed about 13 tonnes and thus occupied most of the space in the tubular rocket. At the upper nose cone of the rocket was kept the passenger—the 35 kg Rohini satellite—under a heat shield. The purpose of the heat shield was to protect the satellite from heat generated due to friction with the lower, dense atmosphere of earth when the rocket traverses through it at a high speed. As such the satellite has no function except to tell the ground stations how perfectly it was injected into space by the SLV-3 and, secondly, its whereabouts so that the stability and other parameters of its orbit around the earth could be assessed for later use.

The SLV-3 was fabricated piecemeal at the Vikram Sarabhai Space Centre, Trivandrum, and the Rohini satellite at the ISRO Satellite Centre at Bangalore. The satellite was finally tested at the Bangalore center itself, whereas SLV-3 was brought to the Sriharikota Rocket Launching Range (SHAR) on the Sriharikota island, 100 km from Madras, for final testing. A computer tested all the components of the SLV-3 and the satellite before giving an okay for the countdown and fire. Due to an electrical snag at the eleventh hour the firing of the SLV-3 was not done on July 17 as was earlier scheduled. Subsequently, the snag was removed and when the computer gave a green signal in the early hours of the next day that the countdown began. As the countdown proceeded the various cable links, the stands supporting the rocket, etc., were disconnected from the rocket one by one so that it was free to go straight up when the countdown zero was uttered.

Launch of SLV-3

The weatherman had given the okay but still a few streaks of clouds were up in the sky when the countdown began. In the morning sun the body of the rocket shone, its pointed nose-cone set for the skies above. At precisely 8:03:45 A.M. (IST), a cloud of smoke was seen at the base of the SLV-3 and the next second it was up in the sky. With a yellowish white, throbbing plume the rocket began to gain altitude, and a few minutes later it was lost into the clouds overhead. Rather suspenseful were these moments for the eyewitnesses but not for the space scientists in their control station of SHAR. Figures on the altitude, angle of climb, etc., began to appear on the control panel as the radars in the neighbouring areas began to track the path of climb of the rocket.

The rocket had in the meanwhile shot up in the south-easterly direction, the easterly spin of earth imparting it additional push to climb up into space. It would not be out of place to mention here that for this additional easterly, free push only the Sriharikota island in the Bay of Bengal was selected as the rocket launching site. The four stage rocket was composed of four separable stages or parts, each having its own fuel tank, firing equipment, etc., which had to work in coordination with the other stages to lift the rocket. No sooner than the

Rohini Satellite the payload in the SLV-3

first stage fuel tank got empty, it was automatically released from the rocket to fell down in the sea or ocean waters below The next instant the second stage rocket fired off and took the rocket to a still higher altitude until its fuel tank became empty. In such a manner the second, third and fourth stages were one by one dropped once their use was over. The advantage of having a rocket composed of four separable stages and not only one piece is that no unnecessary load, which hinders the rocket from achieving a higher altitude, is carried till the end. Also, the stages dropped in the waters could be recovered and used for a subsequent launch.

While the four stages of the rocket worked automatically one after another raising it to dizzy heights above the dense atmosphere of earth, various other robot systems also began to function in the meanwhile. When the rocket was above the dense atmosphere, the heat shield was released and the passenger satellite was exposed to space. Subsequently, the rocket changed its direction of orientation. Instead of the satellite's top aiming at the stars above, the rocket took a ninety degree turn to make its length parallel to the surface of earth. The satellite was, in other words, set for placement into an orbit At this point in the climb when the fourth and last stage of the rocket had achieved the requisite altitude, the satellite was spun about its axis by means of motors and was then injected into space with a tremendous speed, like a cannon ball The satellite thus began to go around the earth in a particular path, called orbit.

The SLV-3 took 12 minutes to launch the Rohini satellite into an orbit of earth. However, it was only 90 minutes later, when the satellite had completed one orbit of earth, that the first weak "I-am-here" signals from the satellite were received at the Car Nicobar Station, and subsequently others at Ahmedabad, Trivandrum and Sriharikota tuned in on to the satellite. The satellite has been placed in an eclipse-shaped orbit around the earth whose major and minor axes measure respectively 950 km and 325 km. Further the satellite is spinning about itself at a rate of 165 revolutions per minute and is moving at a speed of 28,000 kmph to complete one orbit of earth in 97 minutes. After every 12 hours the satellite passes over the Indian subcontinent. The satellite will continue to tell its whereabouts during its scheduled nine months of stay in space and at the same time will send data to the Earth Station at Ahmedabad on how perfectly it was injected into space and other trajectory parameters of use in future launchings.

The SLV-3 launch, though second of its kind, was purely experimental in nature. The first launch of this kind, which took place on August 10, last year, had been partially unsuccessful because of a minor flaw in a valve. Now comes the stage when the SLV and its modified versions would be developed and tested. These subsequent launchs would in space technology be called "developmental flights" in that the SLV-variants would launch satellites with specified functions. The basic aim of these flights would be to develop launchers which could place heavier satellites —in the range of 500-600 kg—meant for communications, remote-sensing and meteorology, in higher orbits of earth. To date all the Indian satellites, namely, *Aryabhata*, *Bhaskara*, have been launched by the Russian Intercosmos rockets. Even the latest comsat APPLE (Ariane Passenger Payload Experiment) would be launched by the Ariane rocket of the European Space Agency next year. A plan is therefore on the plate to build a giant complex for developing and testing satellite launcher vehicles that would run on either solid or liquid propellant, or a mix of the two. It is envisaged that by the end of the present decade India would be able to launch her own sophisticated satellites.

DILIP M. SALWI

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# C. P. Snow —a man of two cultures

SCIENTISTS and administrators are much in the news in today's world. Although they do not seem to be dependent on one another, they are very much so. Unfortunately, they do not understand or appreciate each other's language, the mode of working and attitudes. The result is disastrous not only for themselves but also for the society In the same office building, scientists and administrators become strangers to each other. But all said and done, both are, after all, human beings with same weaknesses, aspirations and feel for knowledge. When these two leaders of the society realise this, they

C. P. Snow

become brothers in a universal sense. What to speak of the leaders, every individual acts sometimes like a stranger and sometimes like a brother not only with others but also with himself. *Brother And Strangers* is a eleven volume collection of novels which deal with all these aspects of society and human nature with emphasis on scientists and administrators. The creator of the collection, Charles Parcy Snow, 74, passed away on July 1, 1980, leaving a legend behind him in the English life, letters and science.

Like the writers H. G. Wells and Arnold Bennett, who had left an impress on the English life and society, C. P. Snow was born in a lower middle class family of Leicester, England. His father was a worker in a shoe factory in that town. Early in his childhood Charles became interested in literature, but was at the same time attracted by science. At the sixth class he would have opted for humanities had the subject been taught at the school he was studying. He had only then decided that he would switch over to literature at a later stage in his life. After the schooling he did B. Sc. in chemistry with honours and M. Sc. in physics.

During his college studies he also served in the capacity of laboratory assistant in his own school because free university education was not then so easily available. For conducting research he was, however, offered a fellowship by the Cambridge University and so he opted for the Christ's College. Here he did research on infrared spectroscopy to explain it on the basis of Quantum Mechanics, then a growing field. For his researches, the College Council also elected him as a Fellow. Charles was then considered to be a promising young man sure to make his mark in science. The destiny then served him a quirky turn, the inevitable happen.

By a sheer oversight Snow made a mistake in his research and this prompted him to leave it, once and for all. He had come to realise that the time had come to switch over from science to literature. In the meantime he had already dabbled in novel writing. He had written one detective novel *Death Under Sails* and a science fiction *New Lives For Old*. Possibly the psychic energy which makes a man either a creative writer or an original scientist could not sustain both of his pursuits, and he had to quit one of them. Snow left research but continued to teach science. During this period he wrote his first serious novel *The Search* which narrates the ardours and disappointments of a scientific career. Although, later, he himself felt that it was a false start, it placed him on the pedestal of a budding serious writer. His career as a writer was launched.

On the New Year eve of 1935 Snow had the original idea of writing *Brothers And Strangers* and by 1939 he had laid down the general pattern of the collection of novels now known by the same title. In the same year he left the university and became a civil servant. In the beginning his job was to organise university scientists for the World War II which had then begun. Gradually he began to scale up the ladder of administrative hierarchy, but continued his creative writing all the same except for a small gap of a few years during the war. He was at peak of his career in 1957 when he was knighted for his significant services in the public affairs, science and literature. Later, in 1964, the Harold Wilson Labour Government made him a life peer and appointed him as the Parliamentary Undersecretary of the newly founded Ministry of Technology. When Snow passed away last month he was no more in the "Corridor of Power"—the phrase he had himself coined.

Now it is easy to see that Snow had varied experiences in life. He liked science but not with a passion; he had worked as a laboratory assistant, a research worker, a teacher, and an administrator, and finally as a big boss. Above all he remained a writer and magnanimous human being throughout his life. *Brothers and Strangers* gives a panoramic view of the professional and intellectual classes of the England and the changes that came in them in six decades from 1914 to 1978. This collection of novels is weaved around the life of a lawyer Elliot Lewis and the circle of people around him, some of them being scientists. Some portions of the novels, in fact, depict Snow's own life and experiences. The theme of the novels is mainly power and ambition, which, according to Snow, are the part and parcel of the modern life and cannot be wished away. Of all his novels, the most widely read is *The Masters* which gives an account of the intrigues and stratagems that come into play in the election of a Master in a Cambridge University College. In this novel Snow has clearly shown that a college common room is a microcosm of the world of politics. Besides fiction Snow also wrote a few non-fiction works, namely, *Variety of Men*, *Public Affairs*, *The Realists* and *Science And Government*.

Snow also became famous for his Rede Memorial Lecture which he delivered at the Cambridge University in 1959. It was in this lecture that he talked about "the two cultures", one created by scientists cut off from human and literary values, and the other by administrators who cannot make head or tail of science. He claimed that the creation of these two cultures shows several ills present in the English society or, for that matter, any modern society in the world. While the scientists will continue to produce dehumanising devices in their race for power, the non-scientists will remain totally unaware of them until it will be too late. In other words, the gap between the two cultures has to be bridged, if the creation of a sane and healthy society is the purpose of every human being. Since the lecture the gap between the two cultures has narrowed down in the West, though not wholly. In a country like India with the third largest scientific and technical manpower the gap remains as wide as it was ever.

DILIP M. SALWI

# Workshop on financial management in R & D

TWO workshops were conducted in July by the Management Development Unit, CSIR on "Some Critical Areas of Financial Management in R and D". Over 50 planning and management scientists and more than 30 Finance and Accounts Officers attended the workshop. The programme was aimed at bringing about a general awareness and inculcating some understanding on the recent developments in the field of financial management, specially performance budgeting and zero-base budgeting in the context of the preparation of VIth Five Year Plan of CSIR.

The programme content of the workshops was designed to bring forth the practical problems of applying the methods of project planning, budgeting and accounting and review the gaps that exist between present practices and desired framework. It was emphasized that in view the need of optimizing resource utilization from the point of view of CSIR's interest, there is hardly any option open other than the adoption of performance budgeting and zero-base budgeting at diffrent levels of laboratory performance.

The introduction of Project Management system on a scientific footing was thought highly significant from the point of view of the accountability and freedom of the scientists. It was emphasized that CSIR requirements for information for resource allocation is skeletal involving major projects; but it is in the interest of the laboratories and their managements to build-up somewhat detailed information system for planning and Management Projects efficiently and effectively.

Participants of the two workshops volunteered to undertake Case Studies on Project Accounting and Zero-Base Budgeting. They expressed a feeling that senior scientists including the Directors of laboratories should be involved in the whole process from the very beginning, so that the problems of R &D Project Management are appropriately identified and measures are adopted to apply the concepts and techniques of management of R and D in general, and Planning of Budgeting methods in particular

The workshops made the following recommendations :

(a) Performance Budgeting should be introduced in all the CSIR laboratories in the interest of effective Project Management and optimum resource utilisation; Project Accounting should be introduced as a part of Performance Budgeting following the budgetary classification for All India Coordinated Projects (AICPs) and Rural Development Projects (RDPs) and other major projects. The smaller projects would be accounted in terms of areas of research. Manuals and guidelines in respect to Performance Budgeting and Project Accounting have to be developed.

(b) The Zero-Base Budgeting (ZBB) method should be treated as a broad approach rather than a specific technique. The modus operandi for the application of ZBB will vary from laboratory to laboratory. The CSIR should explore the possibilities of switching over to Zero-Base Budgeting framework, but its introduction should be preceded by much spade work and experimentation, both conceptual and organizational.

(c) In order to remove ad hocism in the areas of resource allocation and creation of posts and improve the managerial capability of Project Leaders, the workshops suggested intensification of applied research in the area of Planning and Project Selection, Measurement of output in R & D, Technology Forecasting and Systems Development.

(d) The participants of the workshop felt that alongwith the research and case studies in R & D Management areas training activity should be built up on a bigger and meaningful scale and recommended that a Centre for Management Research & Training should be established in CSIR for continuous refining of management systems to be applied in CSIR and the development of human resources from management point of view.

# MEDICAL NOTES

## Bacteria made to produce human interferon

INTERFERON, discovered in 1957, is an important substance in human body's natural defense against viral infection. It is also present in animals. It is species specific in that only human interferon works in human body. Interferon is believed to have great potential for combating a wide variety of viral diseases including cold and several serious infections, and some forms of cancer. Some efforts in the treatment of cancer patients are now under way in the U.S.A. using interferon imported from Sweden where it is isolated from human blood by very expensive and painstaking processes. Some 37,000 litres of blood yield 100 mg of interferon. An intense competition is on among major drug firms for obtaining large-scalep roduction of interferon for therapeutical uses. Biogen, S. A., an international research group based in Geneva, Switzerland, recently reported its success in making in the laboratory of human interferon by recombinant DNA or gene-splicing procedure. Charles Weissman, Professor of the University of Zurich and Walter Gilbert, Professor of Harvard University in Boston, U.S.A., who were the leaders of the group, announced on January 16, 1980 in Boston that a group of scientists working for Biogen modified common laboratory bacteria to make human interferon and demonstrated that it was biologically active. This group hoped to have a moderate amount of bacteria-made human interferon within a year for research and therapy. Last year, human insulin and growth hormone were produced in bacteria by recombinant DNA technology.

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## Hepatotoxic effects of some chemicals and drugs

ROLE of liver in the metabolism of foreign substances is so central that there is no chemical or drug that is totally free from the risk of causing liver damage (*Brit. med. J*, 2, 1126 (1976). Prolonged use of alcohol and drugs known to be associated with liver damage leads to liver cirrhosis.

Paracetamol is one of such drugs that acts as a direct hepatotoxin causing acute necrosis. It reduces biliary secretion (*Clin. Sci. Molec. med.*-49, 495, 1975). Similarly use of oral contraceptives by women leads to hepatic adenomas showing a clear relationship between the disease and the medication (*New Engl. J. med.* 294, 470, 1976). Except streptomycin almost all the antitubercular drugs are liable to bring about liver damages. Ethionamide or pyrazinamide therapy also checks the liver functions. Certain anti-cancer cytotoxic drugs are reported to cause of hepatic fibrosis and cirrhosis. Intake of steroids and hormones also causes untoward side-effects on liver. Cases of jaundice associated with antibiotics are attributed 22% to erythromycin, 22% to co-trimoxazole, 15% to tetracyclin and 9% to ampicillin.

Alcoholic hepatitis occurs in socially functioning persons without the obvious evidence of self-destructive alcoholism. Carbon tetrachloride and allyl alcohol damaged livers were treated with liver stimulants. Most severe hepatic damages have been noted in cases of chronic and addictive drinking.

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## Valium (Calmpose) —the popular tranquilizer

VALIUM or Calmpose, the brand name of the tranquilizer diazepam, is the most commonly prescribed drug. Its tremendous popularity is due to the confusion in terminology that obscures the fact that it is pharmacologically equivalent to the barbiturates and sedatives. It is used by people suffering from anxiety, tension, fear fatigue and agitation and is also an effective muscle relaxant. Compounds of this type were initially synthesized in 1933. It is a benzodiazepine derivavative and chemically 7-chloro-1, 3-dihydro-1-methyl-5-phenyl-2H-1, 4-benzodiazepin-2-one (Fig. 1). Labo-

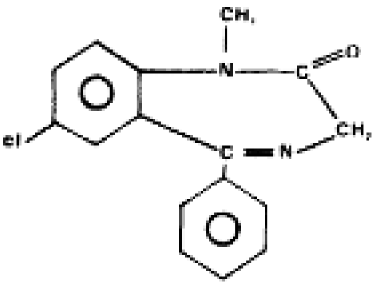

Fig. 1

ratory and clinical studies have demonstrated that the drug has tranquilizing, anti-convulsant properties and is some five times as active as the related chlordiazepoxide (Librium). But it induces more drowsiness and euphoria (a feeling of well-being) The precise pharmacophysiological mechanism by which the drug produces its anti-convulsant effects has not been fully defined. The drug is an effective sedative if given in adequate doses. The claim that anxiety can be relieved without the occurrence of drowsiness as a side-effect is based on experience with small doses. A single dose of 10 mg of diazepam given intravenously induces light sleep without hypotension. Some anesthesiologists regard it as an excellent substitute for barbiturates for induction. It has no analgesic (pain relieving) or antiemetic (preventing vomiting, relieving nausea) properties. It seems to have no effect on the autonomic system and produces little or no depression of the respiratory system or circulation.

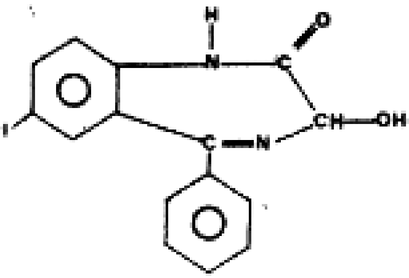

Fig. 2

The drug is relatively non-toxic and is an important reason for its widespread use. It is readily absorbed when given orally and is distributed evenly throughout the body and metabolized in the liver. The metabolism of diazepam includes demethylation and oxidation. It is metabolized to active products, including oxazepam (Fig. 2), one third is excreted as oxazepam and 70% of the metabolites appear in urine. Oxazepam is excreted in urine as the glucuronide derivative after its conjugation with uridine diphosphate glucuronic acid (UDPG A), which is generated from glucose by enzymes and acts as a donor of glucuronic acid. Deaths from the use of diazepam itself are rare and reflects the low inherent toxicity and failure of the layman to identify diazepam as "sleeping pills" suitable for suicide. Sedation (the state of being calm) is the most prominent side-effect of diazepam during chronic oral medication. By its sedative effects, this drug is dangerous to drivers, especially when alcohol is also consumed. The other frequent side effects of diazepam are drowsiness, ataxia (loss of power of muscular co-ordination) and lethargy. Other side-effects include muscle weakness, dizziness, inattention and dysarthria (incoordination or spasticity of muscles used for speaking). Rapid intravenous injection of large doses may produce respiratory and circulatory embarrassment. Large dose may also cause fainting. Occasionally excitement also occurs. Either increased appetite with weight gain, or anorexia (lack or loss of appetite for food) with resultant weight loss, may occur. Enormous doses of diazepam (80mg-100mg) daily given to psychiatric patients for several months produce physical dependence and is more apt to cause dependence than chlordiazepoxide (Librium). Very recently Mohamed Ghoneim, Professor of Anesthesiology, University of Iowa (U.S.A.) reported in his study that users of diazepam could impair their memory. It is not known how the drug affects the memory of patients being treated for severe anxiety. This will be the subject of a study in the future.

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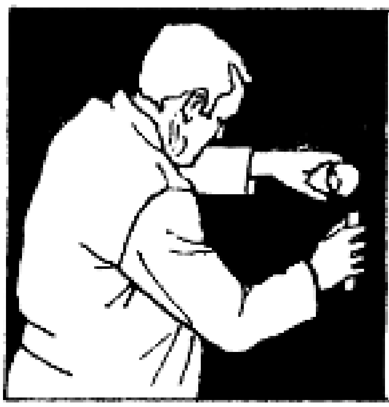
# ISOMERISM

(*Continued from page 509*)

actively engaged in stereoselection of chemical molecules in terms of their usefulness. Future industrial growth to obtain specific organic compounds of selective properties will rely heavily on the technological advances made in stereocontrolled processes.

**Further reading**

1. Eliel, E. L., *Elements of Stereochemistry*, John Wiley and Sons, New York (1969).
2. Hallas, G., *Organic Stereochemistry*, McGraw-Hill, New York (1965).
3. Herz, W., *The Shape of Carbon Compounds*, W. A. Benjamin and Co., New York (1964).
4. Klyne, W. and Buckingham, J., *Atlas of Stereochemistry*, Chapman and Hall, London (1974).
5. Allinger, N. L. and Eliel, E. L. (Eds.), *Topics in Stereochemistry*, Interscience, New York (1972.)



# SCIENCE FOR THE YOUNG

## Time-keeping of the world

SUPPOSE you ask yourself a question : What is time? You will discover that it is very difficult to answer it. The question is not new. It has bothered man since his origin on this planet. Many philosophers have pondered over it. The answer is, however, not a simple one. Time is something we all intuitively understand but cannot explain if asked to do so. In this article, we shall not consider this vexing question since it has philosophical connotations. We will explain instead how the world's time is kept. We will adopt a simple working definition of time : it something that advances as events succeed each other progressively.

The idea that time is a progressing succession of events is relatively new The ancient people thought of time as cyclic. In our own mythology *Satyuga*, *Dwayaryuga*, *Tretayuga* and *Kaliyuga* are supposed to follow each other cyclically In many ancient civilizations the dead were buried along with their belongings and food for any future need. In some cases the dead were buried in crouching positions, along with their worldly possessions, as if they were entering the womb of the mother earth to be born again.

To us the measurement of time by watches and clocks seems quite natural. But think of the time when man came out of the caves to live in the open, having established his supremacy over the rest of the animal kingdom. Man at that time had very little notion of the elapsing intervals of time. Slowly he started realising that there was order in the occurrence of certain events. He found that the sun rose, came overhead, went down and then set in a regular succession. This was his first realization of the interval of time we call a day. Then he started discovering certain order in the motion of heavenly bodies. The recurring phases of the moon defined for him an interval of time called a month. Similarly passing seasons. In Sanskrit the word *varsha* for the year is derived from the word *varsha*, the rain. This progress, however, was not as fast as it might appear; it must have taken several millennia to the early man to come upto this state of knowledge.

To define a day, a month or a year is not enough. Smaller units of time had to be defined before man could measure natural phenomena accurately and formulate the laws of nature to be able to understand and control his environment. For this purpose several ingenious devices—sundials, hour glasses, water clocks, candle clocks, etc.—were invented. Many of these devices can be seen these days in museums all over the world. It was not until Galileo in the 16th century hit upon the idea of a pendulum and Huyghens in the 17th century parented the spiral watch spring that clocks

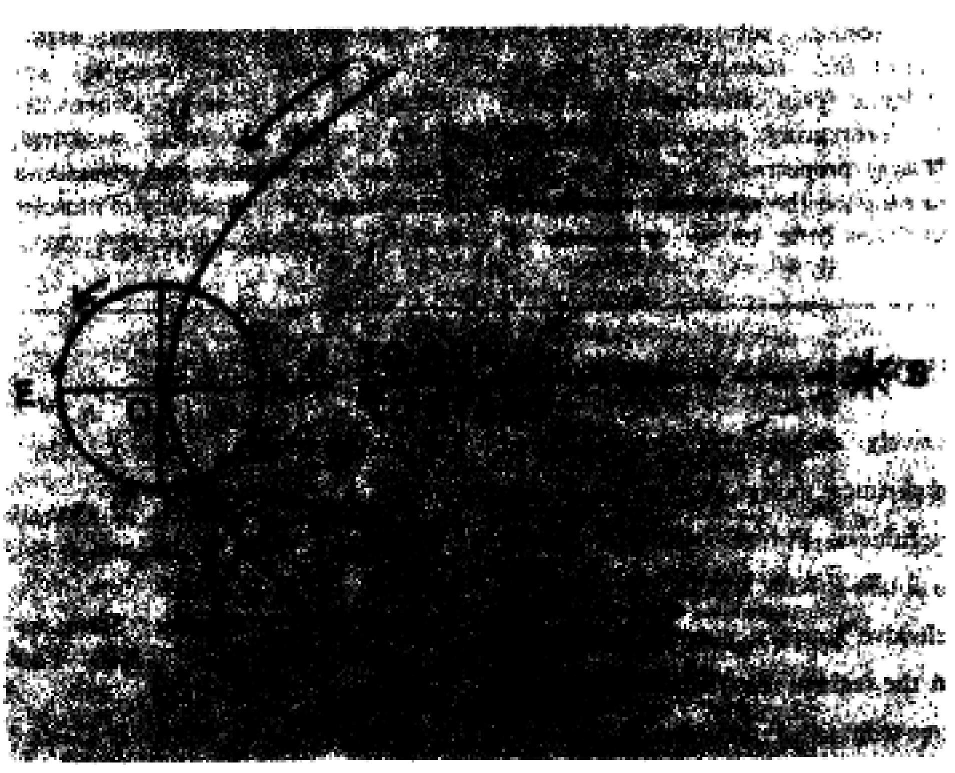


Fig. 1. The position of the earth in relation to the sun and the stars

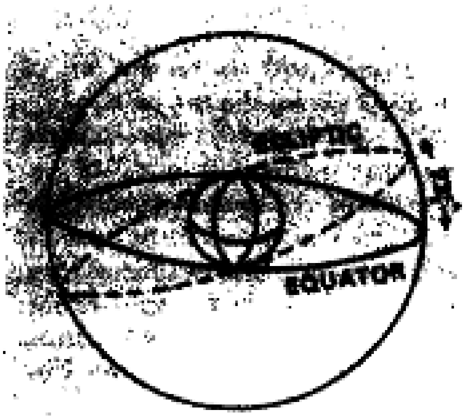


Fig. 2. The earth at the centre of the celestial sphere

and watches came into existence. Since then generations of skilled workers have perfected watches which adorn our wrists today. But however accurate these watches may be, they have to be set from time to time. This is done essentially with the help of astronomical observations. The underlying principle is quite simple and may be explained with the help of a simple experiment which many can perform to check its efficacy.

Look toward south through the window of your house. Fix a reference point, say, the edge of the window, from which you would be observing. See a bright star crossing, say, the pole of a television antenna and note the time by your watch. Observe the same star next night exactly from the same point passing across the same pole and note the time. If the time by your watch is four minutes less than it was the previous night, your watch is good. If the time difference is 3 min. 56 sec., your watch is excellent. The astronomers who are entrusted with timekeeping carry out similar observations, but with very sophisticated instruments.

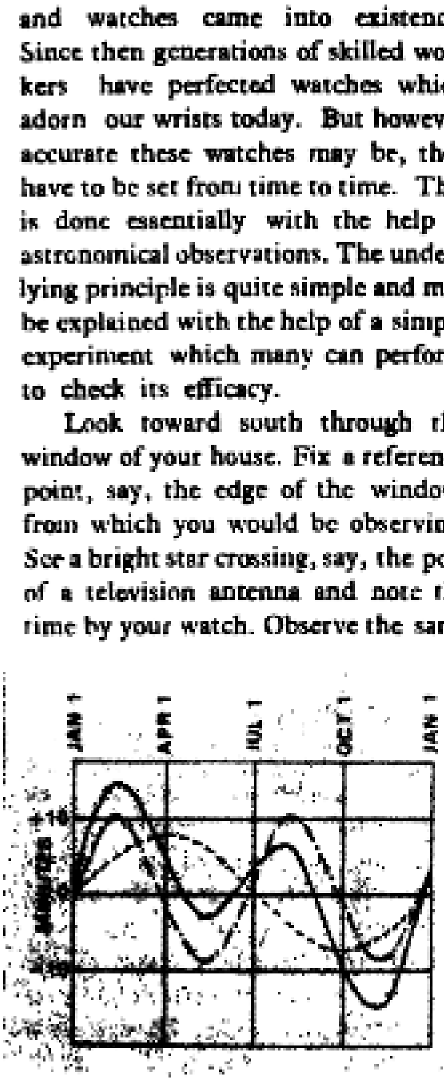


Fig. 3. Equation of time. It shows the amount by which the true solar day differs from the mean solar day. The dotted curve shows the effect of the ellipticity of earth's orbit. The dash-dot curve is the effect of the obliquity of the orbit to the equatorial plane. The solid curve is the combined effect of the two

To understand the origin of the difference of 3 min 56 sec., look at Fig. 1. Here the earth is shown in relation to the sun and stars. The stars are so distant that they may be regarded as fixed. At point $E_1$ of the earth, the point A is directly below the sun and stars. So at A it is noon with respect to the sun (the solar noon) as well with respect to the stars (the sidereal noon). A day later the earth has moved to the position $E_2$. At A it is once again sidereal noon while the sun is not yet exactly overhead. So a sidereal day has been completed at A. A sidereal day equals a 23 hrs. 56 min. 4.091 sec. of mean solar time. This is not the true period of earth's rotation. The latter is 23hrs.56min.4.099sec. The difference between the true period of rotation and the length of the sidereal day is due to the precession of the earth. To complete the solar day, the point A must move to position A', that is, it must rotate through an additional angle AOA' or $E_1SE_2$. The time taken to rotate through this additional angle is the difference between the sidereal and the solar day. Since this angle is covered in one day it is approximately equal to 360/365 degrees, or roughly one degree. The time taken by the earth to turn through one degree equals 24×60/360 minutes, or about 4 minutes.

The difference between the solar and the sidereal days is a variable quantity. There are two reasons for this. Firstly, the earth's orbit is elliptical (Kepler's first law) and therefore its orbital motion is not uniform. This means that the angle $E_1SE_2$ is not constant and consequently the difference between the two kinds of days is not constant. Secondly, the orbital plane of the earth is inclined to its equatorial plane (Fig. 2). The effect of this obliquity is little more difficult to explain but the net effect is once again to vary the difference between the solar and the sidereal days.

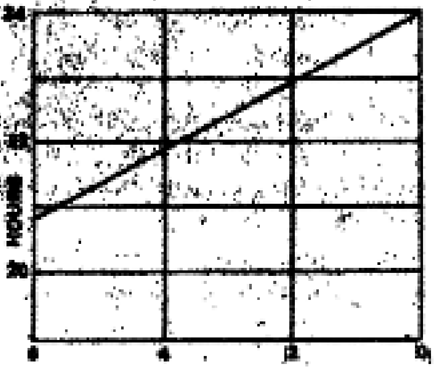


Fig. 4. The gradual slowing down of the earth in the last 600 million years

Life on earth is governed by the sun and therefore only the solar day can be used for civil purposes. If we were to use the sidereal day for civil purposes then we will have times when the civil noon will occur at the solar midnight and civil midnight will occur when the sun will be at zenith. However, the length of the day used for civil purposes should be constant. This is done by defining a fictitious body called the mean sun which goes round the earth in a circular path in a plane parallel to the equatorial plane of the earth. The time derived from the mean sun is called the mean solar time. The difference between the mean solar time and the true solar time, called the equation of time (Fig. 3), enables us to calculate the mean solar time any time of the year. The length of the mean solar day is then used to define smaller units of time. For instance, a mean soler second equals 1/86,400 of mean solar day. The mean solar time at Greenwich (GMT) is taken as the basis of the world's time. The standard and zone times are then derived from it depending on the longitude of the reference place chosen.

For astronomical observations, however, we use only the GMT or, what is also called, the universal time (UT).

It must have been clear by now that time-keeping is intimately connected with the period of earth's rotation. That is why we must keep track of the variations in this period There are regular as well as irregular variations. It has been found from the study of the annual growth bands on fossil corals that the spinning motion of the earth has been continuously slowing down over geological time-scales Coral is a substance deposited at the bottom of the sea formed of the hard skeletons of various sea organisms. The growth bands on corals consist of daily ridges. From counts of the daily ridges the number of days in a year have been determined. It has been shown that the length of the day has increased from about 21 hours to 24 hours in the last 600 million years (Fig. 4). The cause of this continuous slowdown is the force of friction exerted by the tides which are produced in the shallow waters on the surface of the earth by the gravitational pull of the moon.

There are also irregular changes in the rotation of the earth, of the order of a second per year. The earth is a solid mass of matter surrounded by a thick atmosphere consisting of air and water vapour. Any change in the atmosphere resulting in a shift of a large mass from one location to another can cause a change in the rotation of the earth. These and other unpredictable changes have forced astronomers to introduce a new system of time based on the more uniform revolutionary motion of the earth. This system, called the Ephemeris Time, was introduced in 1957. It differs slightly from the mean solar time.

The continuous quest for greater accuracy in the measurement of time has compelled scientists to define a new standard of time, independent of the astronomical observations. This time is based on the characteristic frequency emitted by the atom of the element caesium-133. As we know, the nucleus of an atom is surrounded by the shells of electrons. In the outermost shell of the atom of caesium-133 there is just one electron. This electron may have a spin parallel to the spin of the nucleus, or antiparallel to it. Between these two states of the electron, there is a slight energy difference. If we supply this energy to the atom, the electron goes to the state of higher energy. After some time the electron makes a jump to the state of lower energy and gives out a burst of radiation at a frequency of about $9.2 \times 10^9$ Hz. An electronic radio oscillator is tuned to this frequency and is used to maintain the caesium atoms radiating at their characteristic frequency. This device can then be used as a clock. The accuracy of the atomic clock is about one second in 15,000 years. In 1967 a second of time was defined as the duration of 9,192,631,770 periods of the caesium-133 radiation. This particular figure was chosen so that the atomic time was almost in agreement with the average rate of the GMT during the last century.

Its not that the atomic time has replaced the GMT as the basis of the world's time. The GMT continues to be the world's timekeeper, as it has been for the last 100 years. The slowing down of the earth's rotation is taken into account by introducing changes in the uniform atomic time in steps of seconds (leap seconds) to keep it as close to the period of earth's rotation as possible. The procedure is similar to the introduction of leap days to keep the average length of the year as close to the true period of earth's revolution as possible. The adjustments in the time are done by international agreement. With these adjustments the GMT continues to be the keeper of the world's time.

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# Beautiful corals

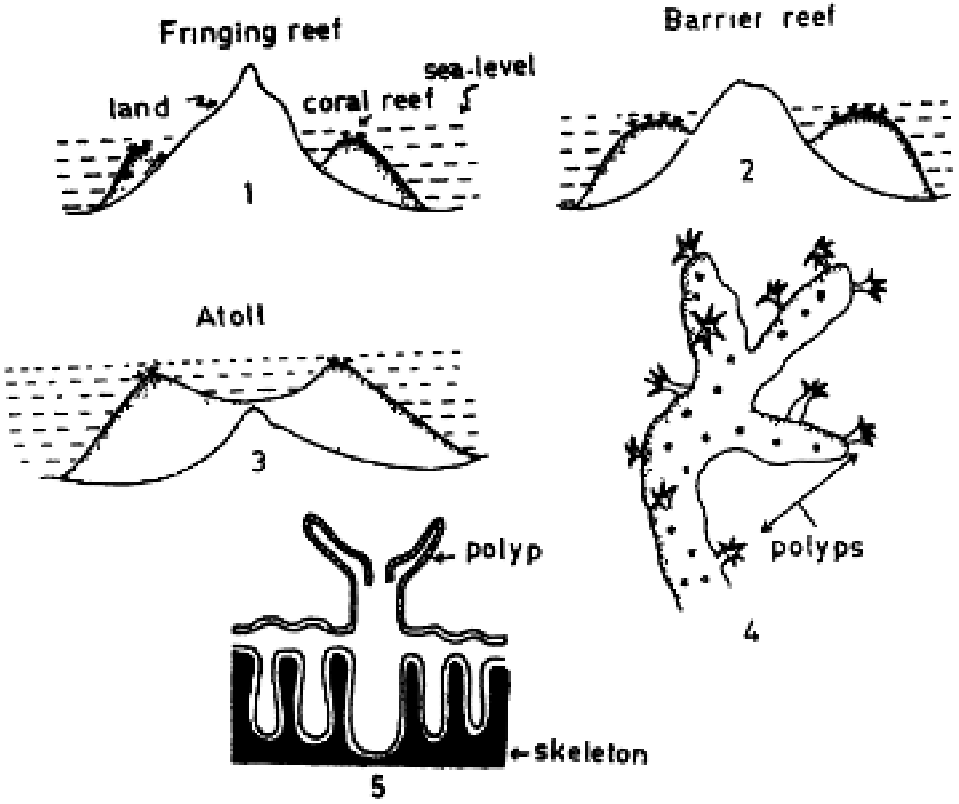
MOST of us are aware of corals but perhaps are not familiar with their biology. For a layman corals are mere inanimate calcareous matter of intricate design and beauty. Corals are actually the skeletal remains primarily of calcium carbonate secreted by living coral polyps (colonial animals) belonging to the phylum Coelenterata.

## Formation of coral reefs

Minute larval forms of corals given off in myriads by adult forms float passively in ocean waters; if they happen to drift with currents of suitable temperature to a shore of firm rock or to a shallow bank where pebbles or shells lie undisturbed by surface waves they may attach themselves there and in time form a new reef. A coral reef thus is a result of the activity of millions of coral polyps over several thousand years. Though coral reefs are seen in depths of 10 m to 50 m, most abundant beds occur in shallow seas only. Coral reef surveys reveal that they are confined to tropical and subtropical seas and are scattered over an area of 190 million square kilometres in a belt around the globe on either side of the equator between latitudes 35°N and 30°S.

### Reef types

Coral reefs are mainly of 3 types, viz., Fringing reefs. Barrier reefs and Atolls. By a process of evolution fringing reefs become barrier reefs later giving rise to atolls (Figs. 1 to 3) In seas around India, all these types are present. 'Fringing reefs' form shallow shelves in shallow waters at or near the shore of the main land or around offshore islands (Fig. 1). Heavy sedimentation and freshwater runoff along many mainland coasts make these less attractive. At the southern end of Indian peninsula, this type is seen as a chain of well developed reefs starting from Rameswaram Island and extending beyond Tuticorin. They are also present in the Gulf of Kutch on the West Coast of India. Barrier reefs are long ribbon like reefs and are asymmetrical in plan and section (Fig. 2). The famous Great Barrier Reef of North-eastern Australia which is 900 nautical miles long is the largest of its kind. Atolls are ring shaped reefs enclosing lagoons. The Laccadives and Maldives possess both barrier reefs and atolls.



**Figs. 1-5. Section of fringing reef (1), Section of barrier reef (2); Section of an atoll (3); Coral polyps (4); Section of a portion of coral colony and its skeleton (5)**

### Biology of coral animals

Though majority of coral animals are colonial in nature (Fig. 4), a few of them lead solitary life. Each coral is a tubular unit Its epidermis is modified to form the so-called calicoblastic layer and secretes a cup-like skeleton of calcium carbonate composed of calcareous fibres radiating from a central core probably of organic material. A considerable part of each coral polyp is inseparably fixed in this cup-like skeleton. The skeleton of a colony as a whole is termed as *Corallum* and of each polyp as *Corallite*. The corallite consists of a cup with vertical ridges radiating from centre to periphery. The bottom of the cup beneath the polyp is called the basal plate. The wall of the cup that encloses the aboral portion of the polyp is called theca and the ridges are known as skeletal septa or sclerosepta. The skeleton is continually secreted by the polyp bases so that the corallum grows both in length and diameter (Fig. 5) In living condition polyps protrude outside from their cavities with their tentacles extended. They fully extend especially during night when they feed on zooplankton. At a depth of a metre or so polyps protrude 4 cm or 5 cm above the level of corallum in bright sunlight. The corallum is thus completely concealed from view. Corals are highly coloured organisms. Blue, pink, liliac, violet, eosine red or tan are very common. Varicus parts of colony may have different colours They are also known as 'see flowers' because of lovely colours. Live corals are a treat to the human eye and are nature's marvels. In the proposed 'Marine Park' to be set up in our 'coral sea', corals, if they survive, are expected to be one of the star attractions.

### False and true corals

Corals are of two types namely 'false corals' and 'true or stony corals' (Figs 6 & 7). The former include the blue coral (Heliopora) with a blue skeleton, gorgonaceans such as sea fans, sea whips and sea feathers with a skeleton in the form of scattered horny or calcareous spicules or a solid axial structure and the black or thorny corals (Antipatharia) with central axial horny skeleton.

True or stony corals possess an external calcareous skeleton secreted by the outer epidermal calicoblast cells of polyps. There are two different views regarding the secretion of skeleton in corals. One is that calcium carbonate is secreted by ectodermal cells themselves, while according to the other, ammonium carbonate excreted by corals interacts with calcium salts of seawater and calcium carbonate is precipitated around ectoderm. Stony corals show wide variations in form, size and mode of growth of their skeletons. *Fungia* has a single corallite. On the other hand, *Acropora*, *Monti-*

*pora* and *Porites* are colonial with several corallites. In size a coral skeleton may range from 1 mm to 2 mm diameter to enormous colonies of several centimeters width and height. A solitary corallum may be conical, cylindrical, patellate, cupolate or fan shaped. In *Porites* coallites are rounded and resemble hillocky masses with heavy skeletons. *Acropora* has a branching tree-like skeleton. In *Montipora* and *Echinopra* the corallum is composed of several thin fronds arranged in the form of petals in a flower. The annual growth of corals is very slow. Based on environmental conditions they may increase in size from few millimeters to 5 cm. Fresh corals have grown over 30 cm within Tuticorin harbour where the breakwaters have only recently been constructed.

### Economic importance

Some corals are highly priced for their decorative value. *Corallum rubrum* is considered as a 'precious stone' in the orient. As it was believed to have sacred properties, people of India and China were said to have exchanged this type of coral for emeralds, rubies and pearls since ancient times. The Romans used to hang branches of coral around necks of their children to safeguard them from danger. Italians are said to wear this to ward off evil eye and also as a cure for female sterility. The red coral is used in medicine since ancient times and even now the organ pipe coral (*Tubipora*) has a place in some indigenous systems of medicine in South India. People of Malay Archipelago and Japan wear ornaments of black corals as preventives for rheumatism.

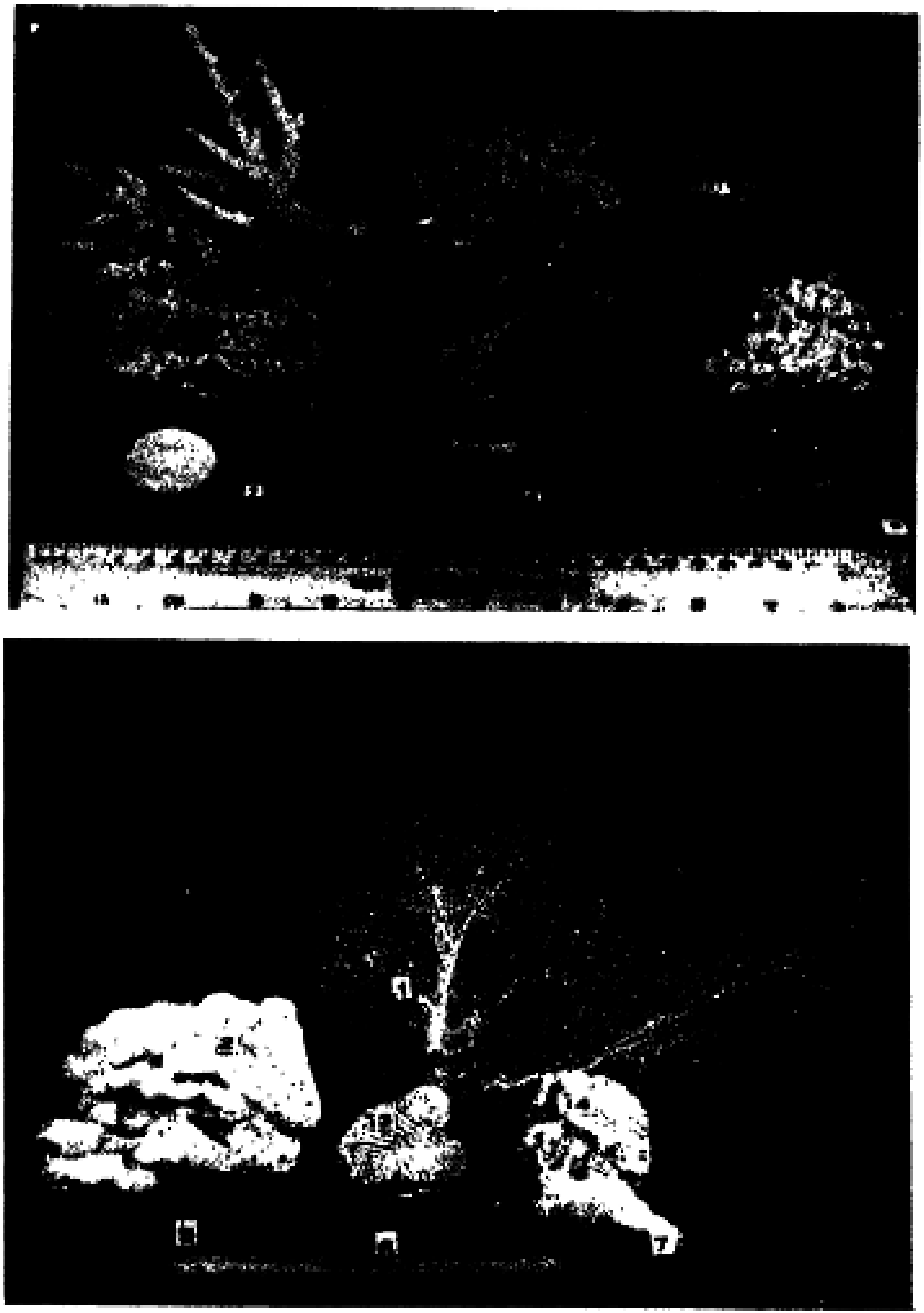


Fig. 6. Some species of corals of Tuticorin coast

Chunks of coral skeletons especially of species like *Porites* spp. are used as building blocks and for metalling roads (Fig. 8). As they are porous, they are said to make houses cool. Corals serve as raw material for the preparation of lime, mortar and cement because of their calcium carbonate content. Some older coral lime stones are rich in magnesium (dolomotized), hence their great value in making cement. They are also used in the manufacture of carbide in South India. Coral skeletons help formation of Islands and may act as natural barriers against sea erosion and cyclonic storms. Old reefs have long served as sea bird sanctuaries and have got bird droppings (guano). When such islands have been long elevated above sea level the guano has leached downward into the coral lime stones leading to phosphatisation, hence the name phosphate islands (e.g., Nauru, Ocean Islands, Christmas Island) which are valuable sources of industrial phosphate. Coral polyps lodge in their tissues some photosynthetic algae (zooxanthellae) in a symbiotic association and benefit by the extra oxygen produced by phy-

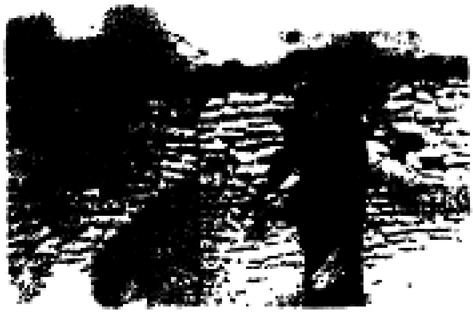


**Fig. 4. Building wall made of coral stones**

tosynthesis. Very often it leads to supersaturation of oxygen in the water around the reefs which is the cause of high productivity of the coral sea.

Coral reefs favour rich submarine organic growth and show a good association of fish varieties. They also serve as good nursery grounds for commercially important fish. Reef fish varieties are more colourful than palatable. Octopi, sea urchins, sea slugs, trochus, oysters and turtles are the other valuable fauna present in coral reefs.

Coral reefs can also cause difficulties to men; ships have been wrecked on unmarked reefs. There are still broad areas in the Great Barrier Reefs of Australia, Coral sea and South China sea marked on the hydrographic charts with the warning 'dangerous ground—numerous uncharted reefs'.

The indiscriminate exploitation of coral reefs on our coasts for making lime and cement is changing their ecology markedly. Damages to the rich fauna and flora of the reefs and surrounding areas are obvious. Protests and legislation have not helped the situation and permanent damage has occurred to the beauty and peace of our unique coral sea. Live coral polyps are often attacked and eaten by animals like starfish and some fishes. Certain parts of the world have attempted to eradicate them and to preserve the natural beauty of corals. Malaysia and Australia have tried to set up artificial coral reefs. Unused rubber tyres tied in a pyramid form in the sea attract coral polyps settlement and an assemblage of fauna and flora. Can we rehabilitate our coral reefs this way? Much more ingenuity and love for one of nature's marvels would be required for the purpose.

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# Brain teasers

### 1 Circles and the numbers

In Fig. 1 are shown five concentric circles and a few numbers. Can you fill in the number that should appear in the central circle?

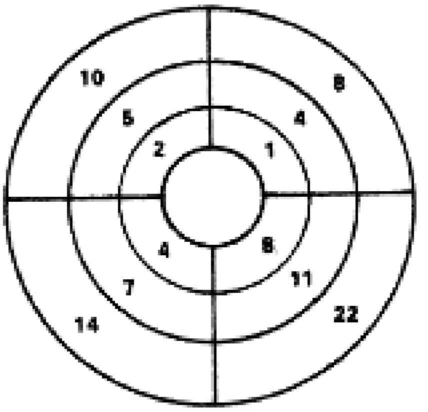

Fig. 1

### 2. Two ferry boats

Two ferry boats ply back and forth across a river with constant speeds. At the banks, they take U-turns without any loss of time. They leave the opposite banks at the same instant and meet for the first time 700 m from one bank. Then both continue on their way to the banks, return and meet again the second time 400 m from the opposite bank. What is the width of the river?

### 3. The car's registration number

The registration number of the car owned by Dr. Saxena, a famous heart specialist, comprises four digits and is a perfect square. It has an added peculiarity in that when the number plate is turned upside down the number still reads the same. What is the registration number of Dr. Saxena's car?

### 4. The census

A few years ago when census was taken in a certain country, it was found that the population of the country was represented by a five-digit square number of the form *ababa*. The sum of the digits *b* equalled the sum of the digits *a*. Can you figure out the population of the country?

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# Science quiz

1. A good source for lipase is
(a) Saliva, (b) gastric juice, (c) intestinal juice, (d) pancreatic juice.

2. X-ray studies is a good technique to know
(a) the three dimensional structure of proteins,
(b) the amino acid sequence of proteins.

(c) the biological activity of proteins,
(d) the amino acid composition.

3. The chemical structure of insulin was elucidated by
(a) F. G. Banting and C. H. Best, (b) J. von. Mering & O. Minkowski, (c) J. J. Abel, (d) F. Sanger & associates, (e) P. Edman.

4. Diabetes in experimental animals can be produced by
(a) oral administration of glucose
(b) removal of pancreas
(c) injection of glucose through blood
(d) administering a crude extract of pancreas

5. Uric acid, but not urea, is excreted as a waste product in one of the species
(a) human, (b) monkey, (c) pigeon, (d) rabbit, (e) frog, (f) shark

6. A rich source for vit. C is
(a) milk, (b) Vitamin B complex tonic, (c) tomato, (d) gooseberry, (e) carrot, (f) orange

7. Paper chromatography is otherwise known as
(a) partition chromatography, (b) gel-filtration, (c) ion-exchange, (d) absorption chromatography.

8. Of the following, which one is a soap?
(a) Stearic acid, (b) sodium acetate, (c) potassium benzoate, (d) sodium stearate.

9. Excretion of bile pigments in urine, indicates
(a) Diabetes, (b) anemia, (c) Jaundice, (d) Cancer, (e) rickets.

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[*See page 563 for answers*]

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# FOR HER

## Ladies, beware of Lady nicotine

WHILE mounting hazards of smoking seem to have made some impact on male smokers, whose number has fortunately come on the descending curve in the last decade, women smokers are alarmingly increasing in number all over the world, and particularly in the developing countries. Although this habit is largely confined to the women of low socio-economic group, both in the urban and rural populations of India, some educated women of the upper socio-economic group are getting into this habit quite unaware of the dreadful consequences. While some feel attracted for the sheer fun of it, many others rate this habit to symbolize modernism, affluence and western ways. A survey in 1976 showed that three-quarters of male students and one-quarter of female students in Lagos University (Nigeria) were users of tobacco. A similar survey in India, particularly in the cosmopolitan cities, can only tell how much this habit has crept into the female student community of India. Anyhow, it is time that women smokers knew of the various health hazards associated with smoking. While the impact of smoking is largely restricted to the male individual who smokes, the consequences in female smokers are two-fold : on the female individual and on the foetus or child she carries or gives birth to. The purpose of the present article is primarily to focus on various aspects of the possible hazards women smokers might have to face, though men smokers should in no way take things easy. To bring this point home, it would suffice to quote a few selected lines from 1979 report of the 'US Surgeon on Smoking and Health' that read—"the death rates of US men who smoke cigarettes are about 10 times higher for lung cancer, 5 times higher for bronchitis, emphysema and asthma and 2 to 3 times higher for heart disease than of men who are non-smokers".

### Harmful ingredients of tobacco smoke

An astonishing number of components, some 4,000 of them, have been detected in the mixture of gases and tarry droplets that comprise tobacco smoke. Of them, over 30 components including radioactive polonium 210 have been suspected to contribute to the various health hazards of smoking. And of these 30, three have been singled out for their notoriety in causing or promoting various diseases. They are : carbon monoxide, nicotine and art.

Carbon monoxide makes up about 3% to 5% of the cigarette smoke. This colourless and odourless gas produced during incomplete combustion of cigarettes is highly toxic and readily binds with haemoglobin of blood to form carboxyhaemoglobin. Haemoglobin of blood has affinity about 200 times more for carbon monoxide than for oxygen. In extreme cases, therefore, smoking results in the reduction of oxygen carrying capacity of blood by 10% or even more.

Nicotine is a dense, oily alkaloid, which is also highly toxic. As little as 4 mg can produce symptom of toxicity in a subject whose body is not used to the drug and 60 mg proves to be an absolutely lethal dose. While pipe tobacco contains between 0.6 and 1.43 per cent nicotine by weight, cigars and cigarettes have 0.75 % to 3% and 0.9% to 1.96% respectively. Nicotine has been reported to stimulate release of adrenaline and noradrenaline which have direct influences on the nerve centres controlling blood pressure and heart rate. Thus excessive smoking may bring in normal individual an increase in heart rate, blood pressure, cardiac output, heart stroke volume, velocity of heart contraction, myocardial oxygen consumption and cardiac arrhythmia. Nicotine has also been found to raise the content of fatty acids in the blood and to stimulate blood platelets to cling to one another and to the walls of blood vessels. It is because of the addiction grown to nicotine that the habit of smoking becomes difficult to give up.

Tar is a dark brown, viscous material composed of condensed particles from cigarette smoke after moisture and nicotine are removed. Strong carcinogens (cancer-promoters) like polycyclic aromatic hydrocarbons, nitrosoamines, beta-naphthylamines, phenols, fatty acids and their esters, etc., are some of the constituents that have been detected in the tar.

### Hazards associated with smoking

*Adverse effects on pregnancy and childbirth.* Because of these harmful components, smoking during pregnancy is especially deleterious not only to the expecting mothers, but also to the foetus as well. According to the review *Tobacco—hazards to health and human reproduction* by S. Coleman and his colleagues of the Population Information Program, Johns Hopkins University, USA (1979), smoking mothers are more likely to give birth to underweight babies and the weight of the baby is likely to decrease along with the increase in the amount of smoke the mother inhales during pregnancy. The gestational period also shortens depending upon the amount the mother smokes. Some complications of pregnancy and labour also appear more in smoking women. The complications include premature rupture of membrane, bleeding during pregnancy, *placenta previa* (a placenta that has developed so low in the uterus that it is in contact with or covers a part of the internal os of the cervix) and *abruptio placentae* (the premature detachment of the placenta). Early rupture of membranes can cause serious complications in the form of premature labour and intra-uterine infections. Profuse bleeding is by itself an obvious risk to the pregnant woman and is associated with higher perinatal mortality (stillbirths and newborn deaths). Smokers experience 25% to 50% higher incidence of bleeding during pregnancy than do non-smokers

Tobacco use during pregnancy has also been reported to increase the incidence of spontaneous abortion In a Swedish study, S. Kullander and B. Kallen (1971) found that proportions of miscarriages involving smokers increased from the fourth month through the seventh month of pregnancy

A team of American researchers led by M B Meyer conducted a survey in 1977 which revealed that the risk of perinatal death in smokers of less than 20 cigarettes a day was 20% more than in non-smokers, but the percentage shot up to 35% for those who smoked more than 20 cigarettes a day. The analysis also showed that perinatal mortality risk increased by 50% to 100% in infants of smoking mothers in the lower socio-economic group. Incidentally, risk of perinatal death of pregnant smokers greatly increased in older women (above 35 years of age) and who have had three or more children.

## Infant health and developmental hazards

Congenital malformations of some form have been linked up with smoking though the results are not yet conclusive. The suspicion is largely based on case studies which show that smoking mothers give birth to more malformed babies than do non-smokers. Data from the British Perinatal Mortality Survey conducted by J. Fedrick and A. B. M. Anderson (*British J. Obs. Gyn.*, **83** (5): 342-350, 1976) show a higher incidence of congenital heart disease in smokers' children—7.3 per thousand births compared to 4.7 per thousand births in non-smokers' babies.

Some researchers suggest that deficient neurological and intellectual development of offspring may be attributed to smoking during pregnancy, though the fact remains to be confirmed beyond doubt.

Smoking during lactation poses another threat to infant health. Milk of smoking mother contains nicotine which is passed along to the baby. If the mother smokes quite heavily, i.e., more than 20 cigarettes a day, she is very likely to bring on nausea, diarrhoea and vomiting to her suckling baby

## Some other aspects of smoking

Smoking might increase liver's metabolism of estrogen. Smokers might experience an earlier fall in estrogen level that in turn brings on early menopause.

An increased risk of cardio—and cerebro—vascular disease, especially myocardial infarction and subarachnoid haemorrhage, lie in wait for those women who smoke and at the same time use oral contraceptives.

The possibility that smoking increases chances of cancer of the reproductive organs is also receiving attention Analysis of (US) Third National Cancer Survey data published by R. R. Williams and J. W. Horm (1977) revealed a statistically significant association between invasive cancer of the uterine cervix and cigarette smoking, with rates increasing as cigarette consumption increased.

In India, P. N. Notani and his coworkers conducted a study of lung cancer in relation to *bidi* (local tobacco wrapped in temburni leaf) smoking in different communities in Bombay (*Ind. J. Cancer*, **14**(2) : 115-121, 1977) and found that cigarette smokers faced a relative risk of 2.36 for lung cancer as against 3.38 in case of *bidi* smokers.

C.R.R.M. Reddy of the National Cancer Institute, India (1974) studied the incidence of carcinoma of hard palate in India in relation to reverse-smoking of *chutta*, a type of home-made cigar smoked with the lighted end inside the mouth, and found the relative risk to be about 1.32 times greater in smokers than in non-smokers. Contrary to common belief that traditional forms of tobacco use are less dangerous than smoking manufactured cigarettes, bronchial cancer in men was found to be more prevalent in men smoking *hookahs*, or water pipes, than in smokers of cigarettes.

Because of its concern over the effects of smoking as an international health problem, the World Health Organization convened an Expert Committee on Smoking Control in October, 1978 to formulate measures for effective control of smoking. In the meanwhile, research has been intensified to find out if smoking is also associated with other diseases.

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# External demand pace maker

PACEMAKER is used for direct heart stimulation in cases of intermittent or complete heart block. Two types of pacemakers, viz., external and internal, are generally used. The external pacemaker stimulates the heart from outside the body, while the internal pacemaker does so from inside the body. The internal ones are mainly used where long-term pacemaking is desired.

The Central Scientific Instruments Organisation (CSIO), Chandigarh, has developed an external type pacemaker, which is a ventricular synchronized demand type pace. A series of electrical impulses of constant current is available from the instrument, which can be used for pacemaking needs. The rate and amplitude of these impulses are adjustable. The instrument is useful for short-term pacing of a patient during pre-operative period.

The device provides stimulation in the demand mode only when an R-wave is not detected within the period corresponding to the set rate. Sensitivity to R-wave signal is adjustable. Care has been taken to avoid the possibility of heart stimulation during the vulnerable period of cardiac cycle. Competition between the stimuli of synchronized origin and the external stimuli of the pacemaker cannot occur. A meter is provided to indicate whether the pulses are from the heart or the pacemaker.

Compact and operational on a 9 V battery, the device can be easily worn by the patient on the belt provided. No special electrodes are needed for synchronization.

The laboratory has made two prototypes and three fully engineered units. Clinical trials have been successfully conducted at the Postgraduate Institute of Medical Education & Research, Chandigarh.

The specifications of the device are as follows :

Mode : continuous and demand
Pulse rate : adjustable from 50 to 150 pulses/min: accuracy ±5%.
Pulse amplitude adjustable from 0.1-20 mA. constant current on loads up to 700Ω. accuracy ±10%.
Pulse duration : 2 ms ±10%.
Sensitivity to detected R-wave : 2 mV min. signal
Meter indications : right deflecting pulses (pulses from pacemaker to heart); left deflecting pulses (detection of R-waves from heart)
Catheter electrode used : bipolar-endocardial (intravenous)

As the device is an assembly-oriented product, general-purpose mechanical equipment like hacksaw, bending machines, press, soldering iron and other hand tools are sufficient for mechanical fabrication. For testing, equipment like oscilloscope, signal generator, power supplies, multimeters, ECG simulator, dB attenuator, etc., are needed. All are available indigenously.

Transistors, diodes, capacitors, resistors, electrodes, switches, cabinet, are the components.

For the manufacture of 500 units of these pacemakers a fixed capital (excluding land and building) of Rs. 0.50 lakh and a working capital of Rs. 1.25 lakh are needed.

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# VHF multichannel electronic tuner

THE Central Electronics Engineering Research Institute (CEERI), Pilani, has developed the design of electronic tuners for TV receivers.

The electronic tuner usually consists of three parts, viz., RF amplifier, local oscillator and mixer. The signal received by the antenna is brought down to the input of the tuner. A filter to select band I or band III is provided to minimize the interference. The selected signal is amplified by the RF amplifier where the in-band channel selection is achieved by the varactor diodes used as the tuning elements. Switching diodes are used to select the required band. The amplified signal is mixed with local oscillator whose frequency is also changed with the help of the varactor diodes and switching diodes. The mixed output is available at the standard intermediate frequency suitable for CCIR standard 'B'.

Ten units of this tuner were made by the institute and subjected to detailed tests and long-duration field trials. Their performance has been found to be good.

The specifications of the electronic tuner developed are as follows :

Supply voltage : 12V (regulated) nominal

(*Continued on page 558*)

# TECHNOLOGY FOR VILLAGES

## Mushroom cultivation

THE Central Food Technological Research Institute (CFTRI), Mysore, conducted four demonstration-cum-orientation programmes, each of two-day duration, during October-November 1979, on the cultivation and processing of the mushroom *Pleurotus Sajor-caju*. The participants included entrepreneurs, farmers and block development officers.

*Pleurotus Sajor-caju* can be cultivated and harvested within 20-25 days in a thatched hut under moderate conditions of temperature (21°C-28°C) and relative humidity (55%-75%). It can be grown on beds prepared with the available rural resources like dry paddy straw, horsegram powder and bamboo structures for 6-8 months in a year at an estimated production cost of about Rs. 5/kg of mushroom.

The participants were shown how to use this mushroom in several popular cuisines.

To popularize the production of *Pleurotus Sajor-caju*, CFTRI supplies, in the initial stages, the spawn (seeding material) required for the purpose.

## Central facility for safety evaluation of pesticides

THE Industrial Toxicology Research Centre (ITRC), Lucknow, is setting up a Central Facility for Safety Evaluation of Pesticides whose short-term and long-term objectives would be : (1) To generate toxicological data on different pesticides synthesized/ manufactured/ formulated by national laboratories and public as well as private sector industries within the country ; (2) To conduct carcinogenic, teratogenic and multigeneration studies on selected strains of experimental animals, *in vivo* tests using bacterial mutants, human cell lines and lymphocytes to map mutagenic and carcinogenic effects and interference with immune mechanism, and to study *in vitro* cytogenetic effects of various pesticides using bone marrow cells of intact animals; (3) To develop new techniques and methodologies for monitoring and predicting harmful effects of pesticides on target and non-target organisms and their diffusion in the environment; and (4) To provide expertise for diagnosing toxic symptoms and developing methods of their prevention.

ITRC has brought out a brochure on the Central Facility. Further details regarding the facility can be had from : The Director, Industrial Toxicology Research Centre, Lucknow.

## SCIENCE IN INDUSTRY

*(Continued from page 557)*

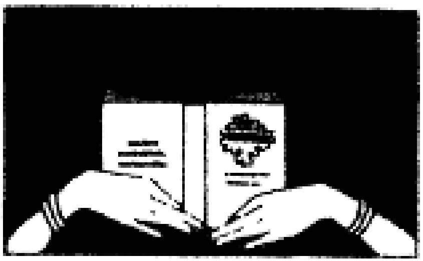
Gain : Band I—30 dB (min.)
Band III—20dB (min.)
Noise figure : Band I—6.0 dB (max.)
Band III—6.5 dB (max.)
Interference : Band I—40 dB (max.)
(IF rejection) Band III—6.5 dB (max.)
Image : Band I—50 dB (min.)
rejection VSWR
without AGC : Band I—3.5
Band III—4.0
with AGC : Band I—4
Band III—4

The raw materials and components required are transistors, varactors, switching diodes, VHF trimmers, feed-through capacitors, coils, IF transformer and glass/copper-clad laminates. The raw materials for the tuner box will have to be procured by the party contracted for this purpose.

Of the equipment required, oscilloscopes, multimeters, power supplies, and VHF signal generator are indigenously available but VHF sweep generators, VHF defectors and noise figure meter will have to be imported.

For manufacturing 5000 units of these tuners per annum a fixed capital (excluding land and building) of Rs. 1.75 lakh and a working capital of Rs. 2.00 lakh would be needed.

The terms for the transfer of knowhow are : lumpsum premium, Rs. 5,000 ; recurring royalty, 3%; nature of licence, non-exclusive; and period of licence, 7 years.



# BOOK REVIEWS

## THE MIGHTY LITTLE ATOM

*by* A. P. Thatte, *IBH Publishing Company*, 412, Tulsiani Chambers, 212, Backbay Reclamation, Nariman Point, Bombay 400021, Pp. 32, Rs. 6.00

HERE is a mighty little book for young readers on a subject of interest to everyone. Within 32 pages the book gives a panoramic view of the history of atomic theories, atomic power and Indian nuclear programme. The manner in which the subject has been dealt with is direct and would therefore help the young readers in grasping the basics of the subject. The multi-coloured illustrations, the short biographies of scientists with their sketches and "Do you know" box items would make the young readers not only love the book but also the subject. In short, the book fills a crying need, and so would the others in the series which are still in print. The publishing company needs to be congratulated on bringing out such a well produced book at such a low price, and it is hoped that the company would continue to pursue the goal of science popularisation in future. Certain things, however, need to be pointed out.

The Editors should have seen that the author does not mention in the book even a single technical term which has not been previously explained. Further, a young reader does not necessarily be told each and every thing happening at the frontline of research at the cost of confusing him. To quote a few examples : "Atomic number" first appears on page 8 in the book in the legend to an illustration, but its meaning is not mentioned until page 13. There was no need of giving the term "scattering angle" in the sketch of the Rutherford experiment on page 10. Wave-mechanics model of atom seems out of place because a young reader will not be able to imagine what charge density means. Besides, there were many other terms mentioned in the text which do not find place even in the glossary—itself redundant in a popular book of this kind. Even the qualifications of the author, that he holds a Ph. D. in physical optics and gaseous electronics, are redundant unless the terms had been explained in the book. Suffice for a young reader to know that the book has been written by a professional scientist.

Subject-wise, the book does not cover the medical and other peaceful uses of the atom. Nor does it give the reader a glimpse into the harmful effects of nuclear radiations. In a "Do you know" item it has been mentioned that a nuclear power plant creates less pollution than a thermal power plant. This pollution question should have been dealt with in a comprehensive manner discussing the pros and cons. In fact, balanced, and not biased, views should be given in such books which have their own impact on the young minds. The dangers of nuclear power cannot be wished away! On balance, a well presented and nicely produced book.

DILIP M. SALWI

## FLORA OF GUJARAT STATE

*by* G. L. Shah, *Sardar Patel University*, Vallabh Vidyanagar, Gujarat (in two parts), Pp. i-vi , 1-1074, Rs. 60.

IN consideration of vast data on floristics accumulated in recent years, there is an urgent need to revise 100 year old Hooker's *Flora of British India*, which is serving the botanical needs of our country to date. The Botanical Survey of India aiming to bring out a well revised flora of India, has taken up 'Flora of India' project for the past few years. It would be complementary to such a national task to prepare up-to-date local, provincial and state floras. One such work is the volume under review.

One can understand from the extensive bibliography given at the end of Part II of the volume that though it is a compilation of works of several earlier researchers, most of the work is either conducted by the author himself or by his Ph. D. students under his supervision and so it is original and first hand. Besides it is the first state flora published in independent India.

The volume includes 1800 species of plants belonging to 791 genera spread over 150 families. Twenty pages in Part I have been given to discussions on geography, soil, climate, forest types, vegetation pattern, parasites, seasonal changes, effect of biotic factors and economic importance of plants. Systematic enumeration of species is given in pages 47 to 882. Although the order of families followed is of Bentham and Hooker (*Genera plantarum* 1862-1883), the circumscription of the families is as given by Hutchinson (*Families of Flowering Plants* 1959). Since similar pattern is also followed by most provincial and national Herbaria, handling of this volume is easy and convenient. Using microscopic characters, as far as possible dichotomous keys for the identification of families, genera and species are given.

Nomenclature adopted here is up-to-date and consistent. Pertinent literature from India and abroad and the *International Code of Botanical Nomenclature* (Stafleu, 1972) have been followed. *Flora of British India* names also are given as synonyms wherever there is a change of name. Towards the end of Part II detailed indices for Latin and local names are given besides extensive bibliography. Even-though an 'errata' is added, certain punctuation and typographical errors have still crept in as the author himself has confessed in the preface.

Since the time of publication of Cooke's *Flora of Bombay Presidency*, several new records of taxa for India or the erstwhile Bombay presidency have been reported. Illustrations for such taxa could have enhanced the value of the volume had they been given in this monumental work. However, it certainly serves the current needs of phyto-geographers, geologists, ecologists, foresters, farmers, pharmacognologists, systematists, teachers and students.

B. Suryanarayana

**SCIENCE OF ENGINEERING MATERIALS VOL. III** *by* Manas Chanda, *The Macmillan Company of India Limited*, 2/10, Ansari Road, Daryaganj, New Delhi-110002 (1980), Pp. 232+XIII, Rs. 15.00.

THE book under review is the third volume of Science of Engineering Materials. The review of the first two volumes of the book has already appeared in *S.R.*, April 1980. This volume describes the different properties of the materials which are useful in the study of materials science today. The subject matter of this volume is based on the basic physical concepts described in the first volume and the structural and behavioral concepts of different engineering materials discussed in the second volume. Materials science is a subject where pure science interacts with technology, so a knowledge of different properties of the materials of critical importance to technology is required. The author has successfully dealt with this aspect of the subject.

This volume is divided into five chapters. Each chapter is devoted to different engineering properties. The first chapter describes in detail the mechanical properties of materials—a critical factor for selection of materials for any technological device whose primary function be either mechanical or non-mechanical. The second chapter is devoted to electrical, electronic and optical properties. Using the basic concepts which are already described in Volume I, the author has briefly discussed various topics pertaining to these properties. In the third chapter magnetic properties of materials have been discussed. An account of the fundamentals of magnetism and various kinds of magnetic materials is also given. However, the author did not introduce the concepts of fine particle magnetism or the uses of magnetic materials in different magnetic devices even in an introductory manner.

Another matter of primary concern to a material scientist is the change of different properties of materials with thermal change. The different aspects of thermal properties, including thermal protection of materials, are discussed in the fourth chapter. In the last and fifth chapter the author has given an account of the causes and methods of prevention of corrosion—a common disease which causes deterioration of materials due to chemical interaction with environment. Effect of radiation on the properties of metallic, ceramic and polymeric materials have also been discussed in the chapter.

The book provides a systematic introductory study of materials science and can as well serve as a text-book for students of materials science. The volume is provided with a number of solved and unsolved problems, explanatory notes and useful appendices which make it suitable for self-study

Bibek Banerjee

**THE STUDY OF MAN** *by* E. J. Clegg, *Hodder and Stoughton*, Second Edition, 1978, £ 3.25 (Available from *B. I. Publications*, 359, Dr. D. N. Road, Bombay-400023)

HEREDITY, environment and culture have all been forceful influences in the development of man's unique biolgoical nature, and any broad assessment of him as a species must therefore be inter-disciplinary in its approach.

According to the author, this new, thoroughly revised edition follows the theme of the original book and presents an ecological consideration of the types and causes of variation found within and between human populations. The author's attempt is two-fold. First, for those whose work involves a knowledge of the structure and function of the human body, the author has tried to describe some important features of the population biology of the species, Homo sapiens. Secondly, for the general readers, he has given an account of not only why do human individuals and populations differ in many more ways than the traditional ones of facial features, size, skin colour, etc., but also many of these variations are, or have been, of great biological significance.

Human biology is defined as the study of the nature and causes of human variation. Variation exists at all levels of organisation, from the molecular through the cellular, individual and population, to the species. This book deals mainly with variation within and between human populations, although references are made to other levels also when required.

The book has seven chapters. The first chapter relates to the historical aspect of how man came to be studied, starting from the Egyptians and the Greeks to the establishment of International Biological Programme to study man, which ended in 1973 and finally to the emergence of the Human Adaptability Project. Some of the work on Human Adaptability is being carried on in a UNESCO Programme entitled "Man and Biosphere".

The second and third chapters describe genetics, the study of human variation and senescence, and begins with an elementary exposition of human genetics, which is essential for the understanding of human biology.

The last part of the chapter describes human variability *per se*, both from the genetic and environmental points of view as they are complementary to one another, which is well documented in the chapter on evolution (Chapter 4). Some principles of demography and population biology are also discussed.

The question of man's ancestry and the way in which he eventually attained his present form is dealt with in the chapter on 'Evolution of Man' where the description and significance of fossil remains is well described. How the fossilized skeletal remains of man's ancestors tell us something about the size and shape of man's ancestors, an idea of how he moved, how old he was when he died, etc., are described in this chapter.

Chapter five 'Man and his environment' deals with the intimate relationships which exist between man and the various sorts of environment in which he lives. Here the term 'environment' is not in the climatic sense like temperature, sunlight, humidity, etc., but encompasses all the external stimuli which may act on human individuals or populations. So, occupation, economic conditions, social relationships, nutrition, other animal and plant life, including disease-causing agents such as bacteria and viruses all constitute important elements in the 'environment'. The interaction between man and these environmental factors are described in this chapter.

How successful an animal is man, forms the sixth chapter. The simplest criterion for success of a population, or of a species, is its total number, i.e., a successful species is one which maintains or increases its numbers. By this criterion, man is undoubtedly at the moment a successful animal, with an annual increase in numbers of about 2.5 per cent. His colonisation of almost all significant habitats, his capacity to protect himself from his environment and his ability to adapt it to his needs are his other qualities which prove that man is the most successful animal that has ever lived.

Until a few years ago it was assumed that the man's successful past and present would be followed by an equally successful future. These optimistic views of the future received a series of shocks during the present century and we are now beginning to think, what will be the future? This forms the last chapter of the book 'Mankind now and in the future'. It deals with the areas of concerns and difficulties such as population, resources, including food and environmental damage. Almost all the problems seem to be associated with the interaction of population increase and the high economic expectations. In other words, there is 'expectation explosion' with 'population explosion'. It further describes the ways in which man might provide for himself in a world where resources are not infinite, and where problems of affluence, pollution and over-population are ever present.

This book shows that many of man's diverse characteristics are of great biological significance and students of human biology in many fields will find in it much to sustain their interest. Pricewise, the book will be acceptable to all.

NARINDER K. SATIJA

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**A TEXTBOOK OF MODERN PHYSICS** *by* S. S. Bhatti, *Kalyani Publishers*, 4862/2 B, Bharat Ram Road, 24-Daryaganj, New Delhi-110002, 1980, Pp. 455, Rs 27.00

THE revolutionary concepts of relativity and quantum physics have, undoubtedly, added new dimensions to our physical knowledge of the universe. In fact, they have so completely and so radically changed the old ideas incorporated in the nineteenth century classical physics that the present-day physics has virtually come to be treated and studied under separate title of "Modern Physics". Recently, a number of books on the topic have appeared in the market. The book under review is one of them but has surely some distinguishing features of its own which makes it different from other books written on the same subject.

The book starts with a note on some basic concepts and preliminaries of the contemporary physics, which forms the introductory chapter of the book. The rest of the book is divided into eight parts including the appendix which is given in part H of the book. In the first five parts of the book, the author introduces to the readers the fundamental concepts and ideas in five major branches which come under the realm of modern physics, namely, relativity and atomic physics, quantum and nuclear physics, and the elementary particle physics. The applications of these concepts to solid state physics and electronics, in particular, are given in the succeeding parts of the book. In doing so, the author takes recourse to only elementary mathematics which can be easily grasped and understood by the students of the undergraduate level.

The book has been updated by including in it information of modern researches conducted in various areas of physics. Even some of the latest events in the international scientific field have been incorporated. These include, in particular, the 1976 Nobel prize winning discovery of the elementary particle called psi or J-particle, the discovery of the Upsilon particle in 1978 and the installation of a new particle accelerator at Argonne National Laboratory (U.S.A.) in 1975. Even the book does not fail to mention the recent scientific advancements made in India, namely, the first Indian atomic test in May 1974 near Pokhran and the launching of the two Indian satellites, Aryabhata and Bhaskara. Some advanced topics lasers and masers; the Raman effect; the Mossbauer effect, etc., are also dealt with in the appendix of the book.

One of the qualifying features of the book is the balanced way and the care and clarity with which the text material is presented. The diagrams are simple and suitably designed, and they help in the understanding of the text. However, all this is marred due to the printing errors that have crept in the book. One will be surprised to see the word "imaginery" being used repeatedly in part A of the book. The price of the book is also little on the higher side. Still it is useful and valuable book and may serve as a reference for specialists as also for those who want to acquaint themselves with the concepts and developments in modern physics.

P. K Mukherjee

**INTRODUCTORY CHEMISTRY** *by* **M.** Katyal, *Oxford University Press*, 2/11 Ansari Road, Darya ganj, New Delhi-110002, Pp. 288, Rs 10.50

It is always a pleasure to see a new scientific text which gives a clear and accurate view of the subject especially for students at the secondary school level. The book under review is just the sort; it gives a concise yet comprehensive account of the various topics in chemistry in a simple language.

The text comprises nineteen chapters (which the author calls 'units') and covers almost all aspects of introductory chemistry. The opening chapter is mainly an introduction. It describes the role of chemistry in modern life, with particular reference to the Indian situation. The subsequent few chapters discuss the various principles which are applied to descriptive chemistry. They include topics such as the structure of atom, periodic properties of elements, chemical bonds, states of matter, chemical equilibrium and electrochemistry. The chemistry of hydrogen and its compounds is discussed in chapters 9 and 10. Then follow five chapters on elements of Groups IA, IIA, IIIA, IVA and VA of the Periodic Table. The chemistry of carbon compounds forms the subject matter of the chapters that follow. The last chapter discusses the various techniques for the purification and characterisation of organic compounds.

The style, language and the terms used in the book are simple. The treatment of the various topics is concise yet comprehensive throughout. At the end of each chapter is given a set of exercises which should prove useful to the students in grasping the basic concepts . It would, however, have been better had the author included some objective type questions. On the whole , the book is a commendable work which will serve as an useful text for students of class XI.

Subhash C. Hari

## Books received

1. **MATHEMATICS EDUCATION** *by* C .V. Bhimasankaram, *Book Field Centre*, Research wing, P. B. No. 7228, Bombay-400 071, Pp. 640, Rs. 150.00
2. **PRACTICAL BIOLOGY** *by* Saxena, Palta and Bhatnagar, *Sultan Chand & Sons*, 4792-23, Daryaganj, New Delhi-110 002, Pp. 128, Rs. 8.00
3. **PHYSICS for Class XII** *by* D. S. Mathur, *Sultan Chand & Sons* (address as above), Pp. 412, Rs. 16.00
4. **FUNDAMENTAL CHEMISTRY (for XI and XII class)** *by* P. L. Soni, *Sultan Chand & Sons* (address as above), Rs. 17.50 and Rs. 19.25.
5. **INTRODUCTORY ECONOMIC STATISTICS** *by* D. M. Mithani, *Oxford & IBH Publishing Co.*, 66, Janpath, New Delhi-110 001. Pp. 299, Rs. 20.00
6. **INTRODUCTION TO OCEAN SCIENCE & TECHNOLOGY** *by* A. K. Malhotra, *National Book Trust*, A-5, Green Park, New Delhi-110 016, Pp. 156, Rs. 9.50

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## LETTERS (*Continued from page 497*)

demand of animals during growth, pregnancy and lactation.

Ajay Kumar Pandey
*Department of Zoology*
*University of Gorakhpur*
*Gorakhpur-273001*

### Suggestion

Sir, I am a regular subscriber to *S.R.*, since 1970. I request you to publish an article on Documentation techniques in science which will be very much useful for research scholars and those working on project work at undergraduate and postgraduates levels.

S. Ghulam Mahmood
*Asst. Prof. of Zoology*
*Presidency College*
*Madras-600005*

## *Answers and Solutions*

### Solutions to brain teasers

1. The number in the central circle is 3. Adding this to any of the numbers in the next circle gives the totals in the following circle. These totals are doubled to arrive at the numbers in the outermost circle

2. Call $a$ the width of the river and designate the ferry boats as $A$ and $B$ (see Fig. 2). $A$ leaves one shore, travels 700 m and meets $B$. If the time for this journey is $t$, the respective speeds of $A$ and $B$ are $700/t$ and $(a-700)/t$. The total distances covered by $A$ and $B$ from their respective shores to the common point S where they meet second time are $(a+400)$ and $(a+a-400)$ respectively. The time taken by $A$ for this passage is $(a+400)\,t/700$ while that taken by $B$ is $(2a-400)t/(a-700)$. As the time for both these passages has to be equal :

$$\frac{(a+400)t}{700} = \frac{(2a-400)t}{(a-700)}$$

This gives $a=1700$. So, the width of the river is 1700 m.

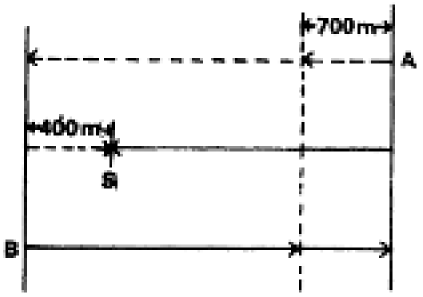

Fig. 2

3. The only five digits which on being turned upside down are readable are 0, 1, 6, 8 and 9. So, the four-digit square number to be determined should be composed of these digits only. From the table of squares, only four such square numbers are found to exist, viz., 1089, 6889, 8100, and 9801. Of these only the number 6889 reads the same when turned upside down, which is therefore the registration number of Dr. Saxena's car.

4. According to the given condition $2b=3a$. As $2b$ is even, $a$ must also be even. Since the population is a square number and no square ends in 2 or 8, $a$ can only be 4 or 6 and $b$ in consequence 6 or 9. The population could thus be either 46464 or 69696. Of these only the latter is a square. So the population of the country is 69696.

### Answers to science quiz

1. (d), 2. (a), 3. (d), 4. (b), 5. (c), 6. (d), 7. (a), 8. (d), 9. (c)

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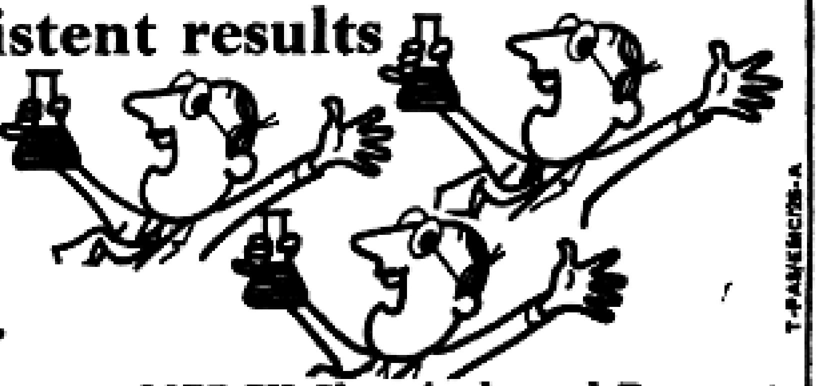

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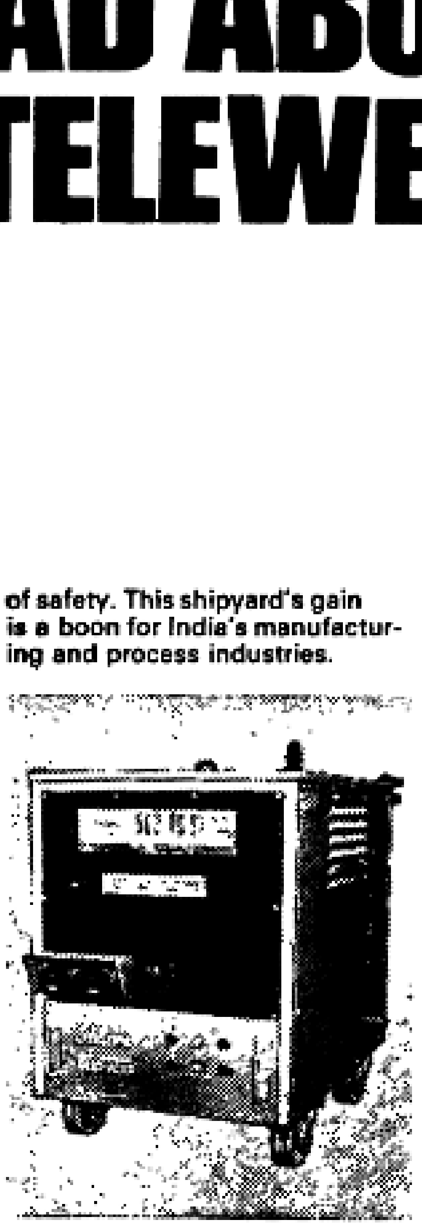

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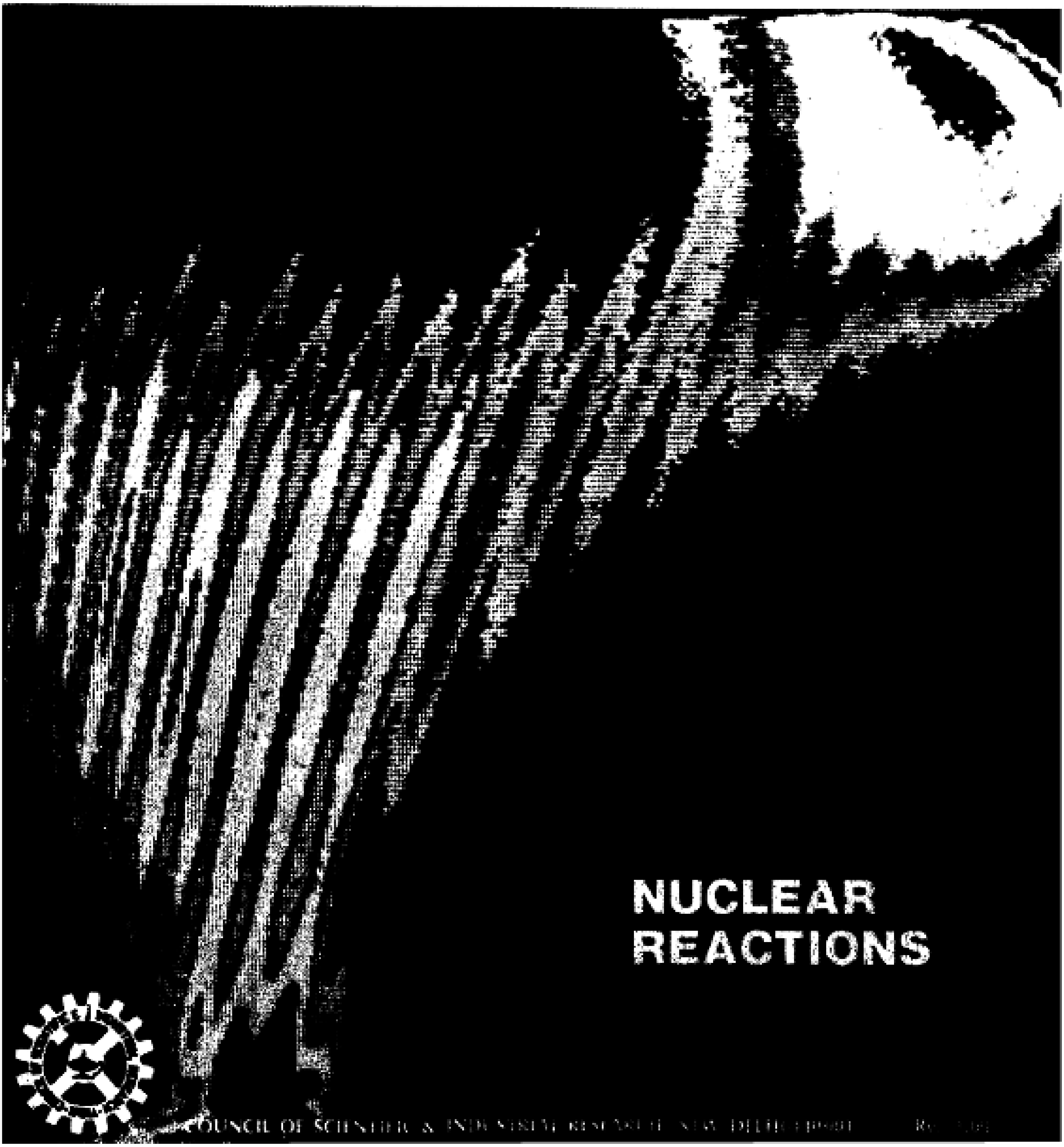

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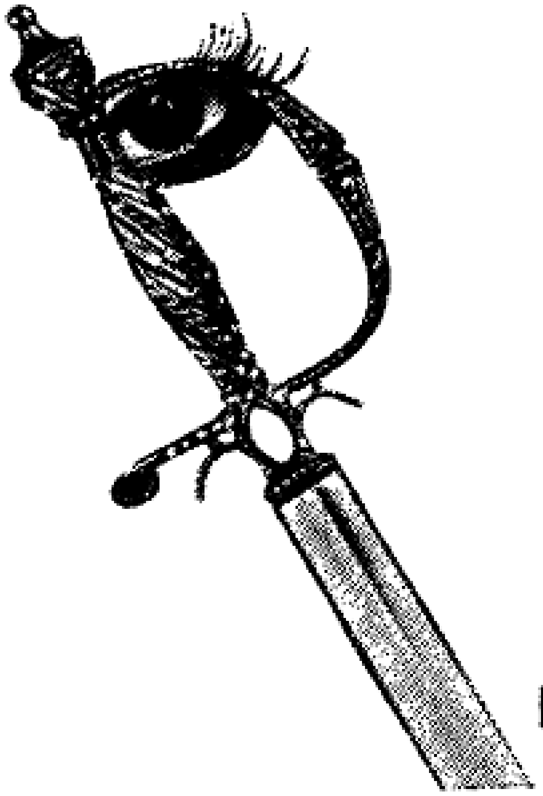

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*Cover*

A three dimensional plot of the reaction products issued from the reaction (Ca + Ca). One can identify the different elements from Fluorine ($Z=9$) to Vanadium ($Z=23$) produced from two Calcium nuclei.

*Courtesy :* the Author

568 LETTERS

571 PLANETS AND THEIR POSITIONS—OCTOBER 1980

MAIN ARTICLES

572 Nuclear reactions *S. K. Agarwal*

576 Servomechanism—principle and applications *Ranjan Chakravarti*

580 Chromosome banding *U. C. Lavania*

584 Hazards of smoking *Raj Mehrotra*

588 Experimental approaches to chemical evolution *Kamaluddin*

594 SCIENCE SPECTRUM

Did earth ever have a ring?—Boron hydrides—Maximum permissible dose—Chloral and its hydrates — Biomagnification of pollutants — Change over to cheese — Cheating genes—Do B-chromosomes affect chiasma frequency and recombination?—How penaeid prawns reproduce—Iodine deficiency and goitre

612 NEWS AND NOTES

Indian Society for R & D Planning and Management—Effect of solar eclipse on human beings and animals

613 MEDICAL NOTES

Acupuncture and anti-bodies—Is betel nut carcinogenic?

615 SCIENCE FOR THE YOUNG

Resonance and its applications—Exercise—how and why?—Science quiz

621 FOR HER

Nutrition for normal vision—All about breasts

624 SCIENCE IN INDUSTRY

Inhibitor for prevention of corrosion in cooling water system—Technology for small-scale sector—Chemical additives for steel and petroleum industries

625 TECHNOLOGY FOR VILLAGES

Agro-technologies

626 BOOK REVIEWS

Ever Since Darwin—Ice Ages—Chromatography of Polymers, Petroleum and Petrochemicals—An Introduction to Operational Amplifiers—Heat and Thermodynamics—Diagnostic Testing in Advanced Chemistry

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# LETTERS

### Indian names of constellations

Sir, In his letter (*S.R.*, May 1980), Pratap Reddy has not succeeded in establishing that ancient Indians had specific names for the non-Zodiacal constellations. A perusal of the list of constellations with their Sanskrit equivalents provided by Reddy shows that many of the Sanskrit names are not original names for the various constellations but just Sanskrit translations of the English names. This is evident in the case of the constellation 'Great Bear' to which Reddy gives the Indian equivalent as "Bruhadruksha" (Great Bear) instead of the Indian equivalent *Sapta Rishi*.

The lack of interest of ancient Indians in the non-zodiacal constellations is not deliberate. In the ancient world, study of astronomy was done for three purposes. First was chronology—fixing the year, month, seasons, etc., second was fixing of appropriate times for performance of religious rituals; the third purpose was navigation and finding directions at night. A study of the movements of the sun and moon was essential for the first and second purposes. A study of the night sky was very essential for navigation and travelling at night. The clear and bright night sky of the desert lands of West Asia provided a good opportunity for watching the stars, studying their movement followed by grouping them into constellations for easy identification. Travel by caravans was a feature of life in these areas since early times and many of the celestial observations must have been made by these caravan leaders. It is therefore not surprising that West Asian astronomers had an edge over their Indian contemporaries in this respect.

Development of astronomical ideas followed a different route in India. Astronomy for a long time was a part of religious studies. Quite early in its development, Indian astronomers had given pride of place to the moon and its movements among the fixed stars. The dates were derived from the phases of the moon. The month also depended on the movement of the moon and each month was named after the fixed star associated with the full moon. Twenty-seven such fixed stars were recognised around the ecliptic. The position of the sun was also defined with respect to the helical rising and setting of these fixed stars. Although a solar year of 365¼ days was known, the year in general use was a lunar year of approx. 354 days which was periodically adjusted with the solar year by the addition of an intercalary month. The Zodiac of the signs seems a much later development than the one of fixed stars. When the Zodiac of the signs was introduced into India, it was just grafted onto the earlier system. The 12 signs instead of being based on the equinox and solstice were based on the fixed stars. The 27 stars forming the ecliptic were distributed equally among the 12 signs, each sign getting the equivalent of 2¼ fixed stars. Traditional Indian ephemeris, when mentioning the transit of a heavenly body from one zodiacal sign to another, always mention the sidereal position also. (For example, when a planet changes from *Mithuna Rashi* to *Karka Rashi*, its new position is also stated as *Punarvasu* 4). The solar year began when the sun entered the star *Ashwini* rather than on the day of the spring equinox (in the northern hemisphere). This may be the reason that although Indians were aware of the the precession of the equinoxes, it never entered into their calendar calculations.

Notwithstanding these differences, Indians made considerable advances in astronomical study. Till about 1200 A.D. they were abreast or even ahead of their contemporaries elsewhere in this field.

S. Krishnamurti
*Chembur, Bombay*

### Bhatnagar Award winners

Sir, We have been your subscribers for about 1½ decades or so and found it highly informative covering almost all the fields like astronomy, statistics, genetics, environment, agriculture, etc. It has been a practice of this magazine to publish life-sketch and achievements, in brief, of Nobel prize winners in science. May we suggest something unconventional, i.e., would it not be good to publish the life-history and achievements of Shanti Swarup Bhatnagar Award winners ? That would be recognizing them in a correct manner. Not only this, whosoever spends Re. 1.00 could get enough biodata of these scientists. Further, such a special series could be continued in 3 or 4 issues to complete the full assessment.

I. K. Mukherjee
M. N. Sadanandan
*Birsha Chowk*
P O. *Hinoo*, *Ranchi 834002*

It is rather surprising that S/Sh. Mukherjee and Sadanandan do not recollect that interviews of Bhatnagar Award winners have been appearing in *SR* for the last five years—Ed.

### Raman Effect

Sir, I enjoyed reading *S.R.*, March 1980. The articles by Jagjit Singh and Riazuddin were absorbing and illuminating.

However, regarding the article **The Raman Effect** by S. Ramakrishnan, I have a doubt. The author says "when a photon hits a molecule, it may be scattered without change of energy or it may give up a part of its energy to the molecule and be scattered with less energy." (p. 171, col. 1). But according to the quantum theory, which forms the basis of Raman Effect, a molecule can absorb or emit energy only in the form of discrete units (photons). Then, how can the photon, as the author says, give up 'a part' of its energy to the molecule ?

I have consulted many books and have found almost the same explanation. I request the author to enlighten me about it.

C. S. Yogananda
*Bangalore-560050*

The reference about photon giving a part of its energy to the molecule is from *Atomic Physics* by J.B. Rajam, 1968, pp. 804.

According to the quantum theory a beam of monochromatic light of frequency $\nu_0$ has the energy distributed in small bundles of quanta, each of energy $h\nu_0$. When such a light quantum or photon hits a molecule of the scatterer, three things may happen. The molecule might merely deviate the photon without absorbing the energy. The molecule might absorb part of the energy of the incident photons giving rise to Stokes lines or the molecule imparts energy to the the incident photons giving rise to anti-Stokes lines. If energy is not lost by the photon, the frequency of incident light will not change. The change of frequency of incident light is a proof for the transfer of energy.

S. Ramakrishnan
*Prof. & Head*
*Deptt. of Biochemistry*
*JIPMER, Pondicherry 605006*

## Pollution-free pesticides

Sir, I read with interest the article **The pesticide threat** (*S.R.*, May 1980).

To combat pollution from pesticides, traditional methods followed by local peasants offer promise and there is vast scope for research in this field.

Neem seed extracts repulse leaf-eating insects. A report on the experiments conducted by Thyril L. Ladd, Entomologist, U. S. Dept. of Agriculture, Washington, reads :

"Ladd coated the garlic-odoured extract of three different types of neem seeds on sassafras leaves which were then exposed to the Japanese beetle—a leaf eating pest. He used five different concentrations ranging from 0.25 to 10 per cent and coated only half of each leaf. The leaves were then put in a container housing 25 beetles. The hungry beetles ate up the uncoated sections of the leaves bare. The coated sections—all but those coated with the lowest concentration—were left untouched. And even leaves with the lowest concentration coatings were just nibbled at. In another experiment, Ladd gave the insects no option; the entire leaf surface was coated. In this case the beetles died of starvation, but did not touch the leaves. Field experiments using Soyabean plants gave similar results. The effects of the extract lasted 14 days. Untreated plants in the same field were heavily damaged. Ladd suggests the neem could yield a strong and safe pesticide to control leaf-eating insects."

Ramesh Saxena, Associate Entomologist, International Rice Research Institute (I.R.R.I.), Philippines says about neem :

"Neem oil seems to have a tremendous potential in management of insect pests of rice due to the following reasons :

(a) It affects the behaviour of the pest by repelling and by reducing the amount of food ingested (antifeeder). The pest on the treated plants dies out of disorientation, starvation and exhaustion and not because of contact toxicity.

(b) Since neem oil is not toxic (non-insecticidal) to insects or other animal fauna, it is completely safe for beneficial insects such as natural enemies (parasites and predators) of the insect pests.

(c) Being a plant derivative, it is bio-degradable, harmless, and therefore environmentally acceptable.

(d) Neem oil is cheap (Rs. 400 to Rs. 500 per 100 kg.) and available in plenty in India through the Khadi and Village Industries Commission."

Sometime back Regional Research Laboratory, Jorhat, found an effective pest controller from a root called *Accurus calamus*. The rhizome of *Accurus calamus* is processed and formed into powder or crushed and collected as oil. The fumes of power or oil are given to the grains after sealing the grain stores to make the insects sterile. The new pest controller has absolutely no side effects.

IRRI recently patented a chemical from an Indian rice variety which is highly effective against stemborers, and certain leaf hopper and plant hopper pests. Being a derivative of the rice plant, it is completely safe to the useful flora and fauna.

There are many plants and plant derivatives which have germicidal properties such as *Annona squamosa* oil, *Tinospora cardifolia* roots, *Citrullus colocynthis* seeds, *Calotropis* leaves, etc.

In our area during sowing of groundnut, the crows are a big menace as they eat away the seeds. Local people mix the latex of *Euphorbia antiquorum* with cooked rice and place it on trees. The crows after eating the rice die within minutes. Obviously latex is poisonous. A thorough study on this latex should be undertaken.

A. Jagadeesh
*Physics Deptt.*
*Roorkee University*
*Roorkee-247672*

## Hot water springs

Sir, Re : **Himalayan hot water springs** (*S. R.*, April 1980, p. 253) by Sharad Singh Negi, I would like to add the following points which might be of interest to *S.R.* readers. Considerable work has been done by A.M.N. Ghosh, S. Deb, D.K. Ray and others for harnessing geothermal energy in India.

The temperature of the earth rises at the rate of about 20°C for every kilometer of depth. At the Mohorovicic discontinuity the temperature is of the order of 400°C to 600°C. Below the mantle the temperature is about 2500°C whereas at the centre of the earth the range is 3000°C to 5000°C.

Various theories put forward as regards origin of geothermal energy are as follows:

1. Radioactive generation of heat in different rock types; 2. Heat flow from high heat flow area; 3. Stress and strain in geosynclinal troughs; 4 .Geothermal gradient in deep aquifer; 5. Exothermic reactions; 6. Volcanic origin; and 7. Meteoric origin.

The disintegration of radioactive minerals generate a large amount of radiogenic heat which is capable of warming up the ground water. The radiogenic heat derived from igneous rocks varies considerably with the silica content. Granites with 65% of silica can generate seven times more heat than the basic rocks with 50% to 55%, of SiO$_2$. Olivinic rocks produce very small quantity of heat. In Idaho, U.S.A., the thermal springs lie in the neighbourhood of batholiths of Cretaceous age. That means batholiths are still discharging magmatic waters.

National Geophysical Research Institute, Hyderabad, is working on sub-surface heat flow studies. The scientists have shown that there are several high, normal and low heat-flow zones in India. Heat flow unit (HFu) has been defined as microcal per cm$^2$ sec. The Dharwar Schist belt is a low heat flow area (0.95 HFu to 1.0 HFu). The Singhbhum Thrust Zone with 1.45 HFu to 1.50 HFu is the normal case, whereas Cambay basin is considered as a high heat flow geothermal province (2.0 HFu to 2.4 HFu). In order to maintain equilibrium heat from a high HF area will flow uniformly through the underlying rock systems to the adjacent comparatively low heat flow areas.

The geosynclinal troughs covered with low thermal conductivity sediments may result in a high heat flow area. Due to accumulation of sediments with huge thickness, the underlying rocks get depressed in zones of comparatively high temperature and in time may lead to the melting of the minerals. A deep circulating ground water reservoir will then get heated up.

Geothermal gradient contributes to a great extent in the formation of hot water springs. In an aquifer at a depth of say 10 km. water may reach a temperature of about 200°C only due to geothermal gradient energy. In favourable combination with any of the other factors the temperature may be still higher.

The temperature of Red Sea brines varies between 56°C to 34°C. Metallic elements Fe, Mn, Cu, Pb have been detected in brine. The sediments recovered from the three brine pools are gel-like and some are amorphous. Israeli geohydrologists maintain that the geothermal pool of meteoric origin. Volcanogenic is geothermal waters contain a high concentration of sulfurous and flow compounds. The subsurface oxidation of minerals like Iron Pyrites (FeS$_2$) yield chemical compounds which may enter into exothermic reactions. The exothermic heat so generated warm up underground water.

In Mulun-L'Alamon (France) it has been possible to utilise geothermal energy by pumping hot water through heat exchanger and reinject the calorie exhausted water into the aquifer and circulation continued.

The Radio building in Paris is heated by geothermal energy using pumps installed on a hot water source 500 m under the ground. In collaboration with UNDP and the Hot Spring Committee of India, geothermal stations are being installed in Pugga valley of J & K and Manikaran in H.P. where surface temperature of hot water and steam is nearly 100°C.

JAGNESWAR D. NATH
*Assistant Chemist*
*ONGC, Sibsagar-785640*

## Drug interaction

Sir, I read **What are drug interactions?** (*S.R.*, April 1980) by E. Venkata Rao and N. Ranga Raju with interest. The authors have reported that salicylates have no anti-inflammatory action by themselves. I would like to point out here that salicylates interfere with with release or effect of pharmacologically active substances (known as chemical mediators of inflammation) such as prostaglandins and brady kinin.

It has been well established that prostaglandins are formed by leukocytes during phagocytosis. Local injection of PGE$_1$ or PGE$_2$ cause marked vasodilatation and hyperemia increase permeability, swelling, pain and induces leukocyte migration into the area (various steps of inflammation).

Salicylates in threapeutic doses block an early step in the synthesis of prostaglandins from precursor fatty acids, by inhibition of prostaglandin synthetase, a complex of microsomal enzymes. Salicylates should be considered as an anti-inflammatory agents.

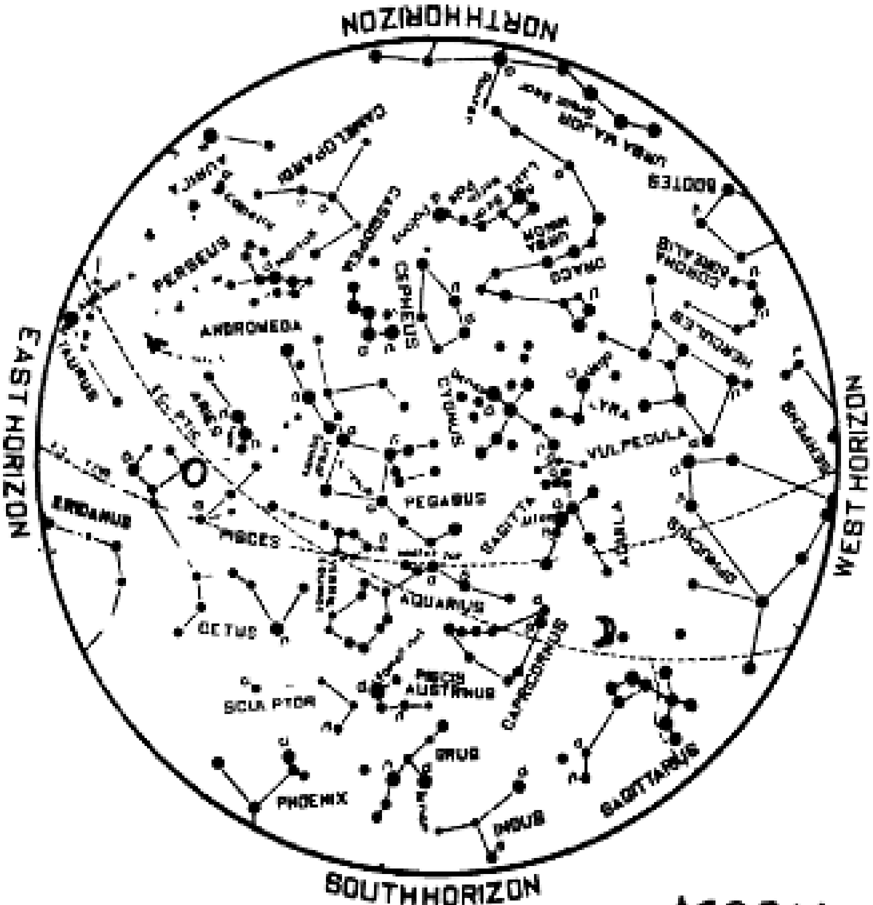
### Further reading

1. Vane, J. R., Inhibition of prostaglandin synthesis as a mechanism of action for aspirin-like drugs, *Nature, New Biol.*, 1971, 231, 232-235.

*(Continued on page 587)*

# Planets and their positions

## October 1980



MOON

☽ FIRST QUARTER 17TH

O FULL MOON 24TH

MAGNITUDES

-1 0 +1 +2 +3 +4 +5

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### The moon

NEW moon occurs on 9th at 8-20 a.m. and full moon on 24th at 2-22 a.m. I.S.T. The moon passes about a degree north of Venus on 5th, two degrees north of Jupiter on 7th, about one and a half degrees north of Saturn on 8th, eight degrees north of Mercury on 11th and about six degrees north of Mars on 12th.

The lunar crescent becomes first visible after the new moon day in the evening of 10th.

The moon is at apogee or farthest from the earth on 9th and at perigee or nearest to it on 23rd.

### The planets

**Mercury** (*Budha*), an evening star, sets about an hour after sunset during the first three-quarters of the month. Thereafter, it is too near the sun to be visible. It is at the greatest eastern elongation of about 25° from the sun on 11th. It becomes retrograde on 23rd. It is in Libra (*Tula*). Its visual magnitude varies from +0.0 to +2.2.

**Venus** (*Sukra*), a morning star, rises about two and a half hours after local midnight during the first half of the month, and about three hours after it during the second half. It passes very close to the star Regulus (*Magha*) on 4th. It moves from Leo (*Simha*) to Virgo (*Kanya*). Its visual magnitude is about −3.6.

**Mars** (*Mangala*), visible in the evening sky, sets about two hours after sunset during the month. It passes about four degrees north of the star Antares (*Jyestha*) on 24th. It moves from Libra (*Tula*) to Scorpio (*Vrischika*). Its visual magnitude is about +1.5.

**Jupiter** (*Brihaspati*), visible in the morning sky, rises about one and a half hours before sunrise during the first half of the month and about two and a half hours before it during the second half. It is in Virgo (*Kanya*). Its visual magnitude is about −1.3.

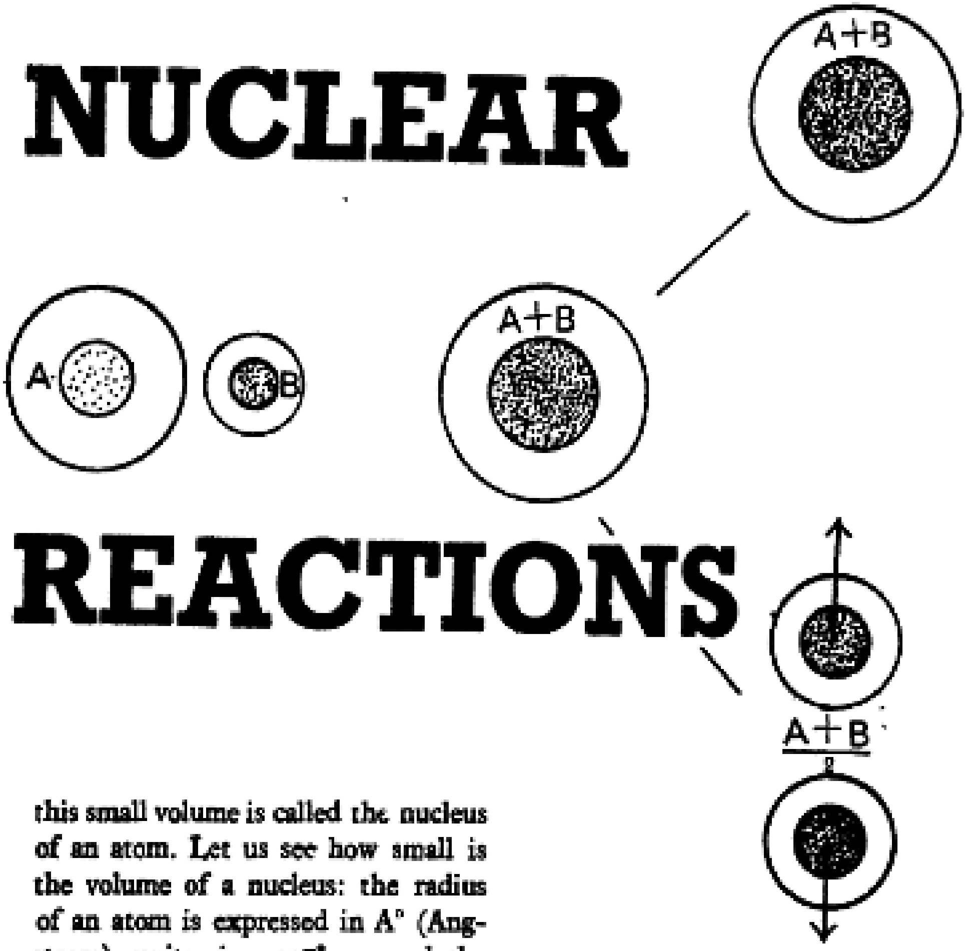
**Saturn** (*Sani*) is too near the sun to be visible during the first quarter of the month. Thereafter, it reappears in the morning sky and rises about two hours before sunrise. It is in Virgo (*Kanya*). Its visual magnitude is about +1.2.

(*Source* : Director, Positional Astronomy Centre, India Meteorological Deptt., P-546, Block 'N', Ist Floor, New Alipore, Calcutta-700053)

# NUCLEAR REACTIONS

SUMAN KUMAR
AGARWAL

**Nuclear reactions have been known for over half a century, but there is yet no single consistent theory to explain them all**



ROUGHLY speaking, atoms are made of three kinds of particles: positively charged protons, negatively charged electrons and the uncharged neutrons. Most of the volume of an atom is occupied by the moving electrons and a small volume at the centre of an atom is occupied by the neutrons and protons. Precisely, this small volume is called the nucleus of an atom. Let us see how small is the volume of a nucleus: the radius of an atom is expressed in A° (Angstrom) units, i.e., $10^{-8}$ cm and the radius of a nucleus is expressed in fm (Fermi) units, i.e., $10^{-13}$ cm. So, when we bring them to the dimensions of volume, we find that the volume of a nucleus is $10^{15}$ times smaller than the volume of the whole atom. Moreover, since electrons have practically no mass, all the mass of an atom is concentrated in the volume of the nucleus and consequently the density of a nucleus is roughly $10^{15}$ times higher than that of an atom. Not only the whole mass of an atom is concentrated in the nucleus but almost all the properties also. Whether, a particular atom should be called iron or gold, does not depend on the electrons but on the number of protons in the nucleus. The weight of an element will depend on the number of protons and neutrons in the nucleus.

When the atoms combine with one another to form a molecule, it is only the outer electrons which participate in the process of combination. The nuclei do not even know what is happening and consequently they are not perturbed at all. In such a case, we call them chemical reactions. But, if we want to change anything of the nucleus, for example if we want to change iron into gold, we shall have to go through nuclear reactions and this is not an easy affair. However, with the advancement of science, it has been possible to study nuclear reactions and this, precisely, is the subject of this article.

**Nuclear reactions**

It is not easy to perturb a nucleus. Firstly, because of their smallness and secondly because of the fact that the nuclei contain positively charged protons and when another nucleus, containing obviously positively charged protons, approach the previous one; there is rigorous repulsion between them. This repulsion is commonly known as Coulomb barrier. Until and unless the interacting nuclei are sufficiently energetic to overcome this barrier, they cannot touch each other. This barrier may be small or big depending upon the interacting nuclei. Some of the nuclei are so big that they cannot even hold their own mass together, consequently, they break apart spontaneously. This phenomenon is called spontaneous fission which is not the subject of this article. We shall mainly talk about the nuclear reactions between two charged nuclei, i.e., each of the interacting nuclei have

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at least one proton and for them the barrier is very high.

Surprisingly, once two interacting nuclei overcome this barrier, they penetrate into each other and from that point, a new attractive force starts acting on them which is called nuclear force.

The first such nuclear interaction was observed in 1933 (discovery of artificial radioactivity).

So, the primary condition for having a nuclear reaction is that the interacting nuclei should have sufficient energy to overcome the Coulomb barrier. At places like the sun, the temperature is so high that all the elements are always interacting with one another to create new elements but on the earth's surface, one has to think of an artificial device to get highly energetic particles. Precisely for this purpose devices have been conceived which are called accelerators. The first accelerator was built about 25 years ago by Lawrence to accelerate. He atoms to a few MeV energy. Today one can accelerate even an uranium atom to a few GeV of energy.

Since the sizes of the nuclei are very small, even if they are highly energetic to overcome the repulsive barrier, they may not be able to touch each other. In other words, it is very difficult to aim at the target because of its smallness. To give an idea, if we hit a target of one atom with $10^{14}$ atoms of a projectile, the chances are that may be one atom will be able to touch the nucleons of the target atom.

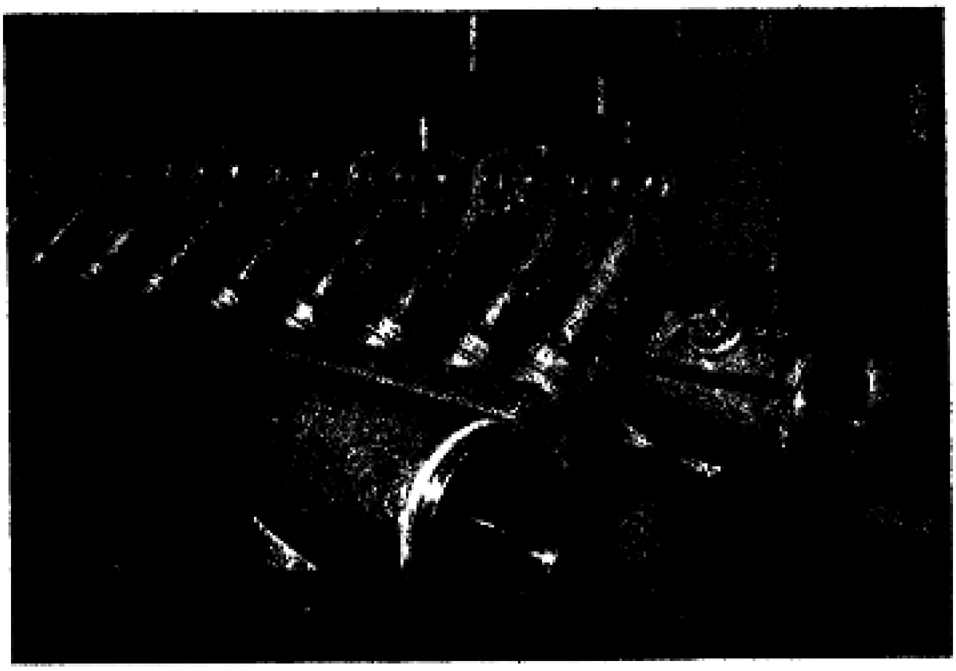

**Fig. 1.** Electrodes of a linear accelerator for accelerating heavy ions by creating a difference of potential between two successive electrodes

## Reaction mechanisms

The collisions between two sufficiently energetic nuclei can give rise to a great number of reaction products depending on the different mechanisms it has gone through. These mechanisms again depend on how close the nuclei come to each other. If one nucleus passes through the repulsive field of another nucleus, it will just try to go as far as possible from the other one, a situation comparable to the one when two enemies come across each other, by chance (Fig 2a).

Same is the case in the situation where the energy of the particles is not high enough to overcome the barrier. In this case, even if the particles are moving for head on collision, they cannot touch each other and they get rebounded from the repulsive barrier. The situation is like when a football hits a wall, the ball is rebounded by the wall (Fig. 2b). The energy with which the ball comes back can be deduced using the laws of conservation of momentum

$$E_f = \frac{E_i (M-m)^2}{(M+m)^2}$$

where $E_i$ and $E_f$ are the initial and final energies of the ball, M and m are the masses of the wall and the ball respectively. It is obvious that all the effects of friction, gravitation, etc., are neglected.

This reaction is widely used in research, for example for analysing the soil of a planet on its surface. The ball is replaced by α particles obtained from radioactive sources (e.g., $^{252}$Cf). Thus $E_i$ is known, $E_f$ in measured, m is known and it is easy to calculate the mass of the nucleus from which it is rebounded. Each $E_f$ value will correspond to an element and thus one can make a rough estimate of the soil composition.

So the reactions of the type 1a and 1b are dominated by the Coulomb repulsive force. The nuclear attractive force has very little part to play, if any at all. Thus, these are the two cases where outgoing nuclei have the same identity as the incoming ones. They are called elastic or direct reactions.

Next come the cases where nuclear attractive force plays the main role in reaction mechanism. If the projectile nucleus passes through very near the surface of the target nucleus, then there is a greater possibility that they get stuck to each other (Fig. 2c). Consequently, they form a temporary di-nuclear system. During the existence of this di-nuclear system ($\simeq 10^{-22}$-$10^{-21}$s) which is very often referred to as composite system, the two nuclei exchange their own properties (energy, mass, charge, etc.) and then they break apart. So, if we look at the products, we will find that there are mainly two nuclei whose masses may not be the same as the projectile and target masses but they are somehow very near to them. Even though they have undergone changes, they have kept their identity. For example, if iron (atomic number 26 ) atoms are bombarded with nitrogen atoms (atomic number 7), we may find the reaction products having atomic numbers between 3-14 and between 19-30. So, one can make out that the first group has come up either by loss or gain of nucleons by the projectile and the second group has come up from the target atoms. This class of reaction is called inelastic or deep inelastic reaction.

Since, in inelastic reactions, the two nuclei have the possibility of touching each other, they find the most extensive use for learning the surface properties of a nucleus. Based on these reactions, different fields of research have been developed to learn the energy exchange process, mass exchange process and the parameters which govern the processes. Recently, it has been shown that the life time of such a di-nuclear system depends on the difference of sizes between two interacting nuclei. If one nucleus is very small compared to another, then the system lives for very short time whereas if they are almost of the same size, life time is almost ten times longer.

Another important use of these reactions has been in creating new isotopes or elements which do not exist in nature. For example, if $^{40}$Ca ions are bombarded on $^{238}$U target with an energy above the Coulomb barrier, and if in the collision there is a transfer of 1*p* and 1*n* from $^{40}$Ca to to $^{238}$U, then we get an artificial iso-

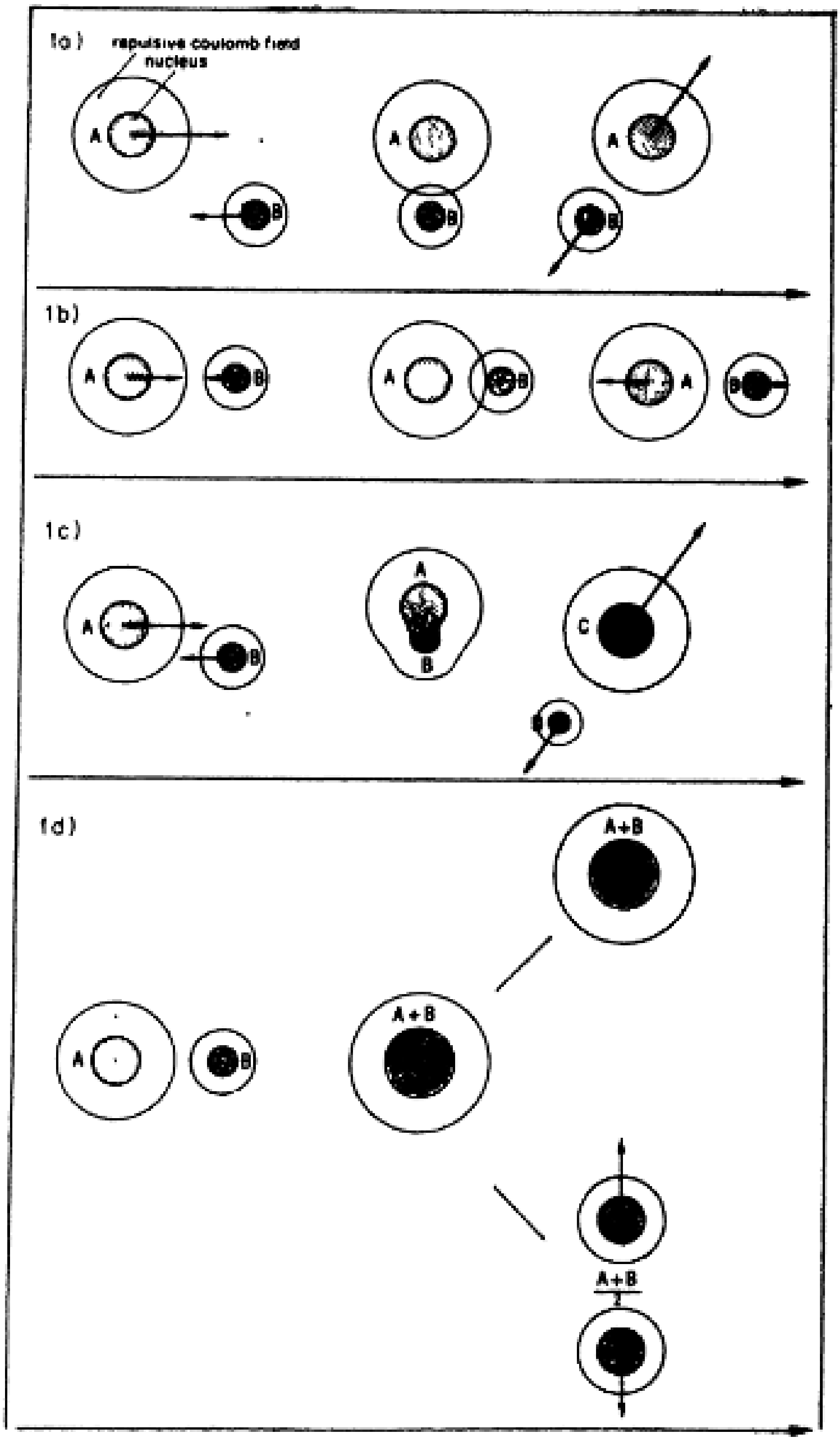

**Fig. 2. (a) Two nuclei moving in opposite directions. The nearest distance between the centres is much more than the total of their radii. They are unable to come in contact; but they are near enough to feel the Coulomb repulsion; (b) Two nuclei moving in opposite directions for head-on collision; but the kinetic energy is not high enough to penetrate the Coulomb field; thus finally they get rebounded; (c) The two nuclei interact with one another to form a dinuclear system. The nucleons flow from B to A, to form D (smaller than B) and C (bigger than A); (d) Two nuclei fuse together to form a 'hot' compound nucleus which may either evaporate few particles to form 'cold' compound nucleus or break-up in two smaller nuclei, being unable to support the fatness and the heat!**

tope of potassium ($^{40}K$) and an artificially created element neptunium ($^{239}Np$). This is one of the most widely used methods for manufacturing unknown isotopes. Till now about 2000 artificial isotopes have been detected.

Lastly, we can have head on collisions between two sufficiently energetic nuclei. This will lead to the penetration of the surfaces of two nuclei and, if the masses are not too big, they will finally fuse together to give a single mass (Fig. 1d). Thus, the total mass of the nucleus thus formed will be the sum of the projectile and the target. For example, if we bombard a tin (Z=50) target with copper (Z=29) projectile of energy around 200 MeV we can obtain gold (Z=79) as the reaction product. Such a reaction is called fusion reaction. In these reactions, the projectile looses all of its initial kinetic energy and part of that will appear in the form of heat in the new born nucleus. (Other part of kinetic energy will be used to overcome the Coulomb barrier and to compensate the energy balance, if the reaction is endothermic). This new born nucleus is commonly known as the compound nucleus (CN). Since the CN thus formed is hot, it has to radiate heat and to do so it can select different ways. One can say that there are two different ways. If the CN is very big in size it may find itself unstable under so much of heat and the result will be breakdown of CN. This is called fission, a term very much known to the general public because of the atom bombs and energy generating nuclear reactors where it finds extensive use. However, we shall touch this point later in this text.

The other possibility for the hot CN to get de-excited is to evaporate away a few particles (n, p, α or γ). This is very much common for lighter CN which are quite stable. Thus, we get a nucleus which is probably a few nucleon less than the CN and it is called Evaporation Residue product. This is probably the oldest known and most extensively studied nuclear reaction.

The fact which supurred the scientists to study this field was that the method had tremendous potentiality of creating new elements. The heaviest naturally occurring element is uranium (U) whose atomic number is 92. It is easy to understand that if we can make a compound nucleus out of uranium and any other element, we should get an artificial element. In fact, this method has been applied to create 14 new elements, heavier and lighter than uranium, which are of great interest. The last such artificially known element is of atomic number 104. But why do we stop there? Reasonably, one should be able to continue to create heavier and heavier elements upto (U+U)!

What happens is such a heavy element is that the repulsion between the positively charged protons of the nucleus overcomes the attractive nuclear forces and the result is that the heavy nucleus ruptures to give two (or may be more) smaller nuclei. Now, is that the last limit for a nucleus to live (Z=104 or 106)? The answer to this question has been given by several nuclear theoreticians who claim that due to some specific arrangement of nucleons in a nucleus, the element of atomic number around 114 should be stable. The kind of specific arrangement they need has already been observed in the naturally occurring elements and this fact gave a lot of aspiration to the experimental scientists to search for these extraordinary elements (so-called superheavy elements), but all in vain till now. At least three groups in the world are still trying periodically to create such superheavy elements by the method of CN formation at Dubna (USSR), Berkeley (USA) and Darmstadt (West Germany).

The most important use of these reactions are found in so-called hydrogen bombs. *May* be this method has got still to find out its best use in the future nuclear reactors where two light ions may be fused together to get an highly exothermic reaction. The fusion between two nuclei of mass less than iron is in general exothermic and above the mass of iron is an endothermic. Moreover, the most exothermic reactions are produced with the lightest ions.

A few words may be added about fission of the CN. Fission reactions in the atom bombs and in the reactors are a little different from the process explained above. For such purposes, one chooses such an atom that it is naturally almost at the verge of breaking down but it just does not. To such atoms, if a small kick is given, they breakdown violently and they are always exothermic processes. To give such a small kick one does not even need an ion, a tiny little neutron is good enough. But where to get these neutrons from ? There is no problem! When the big atoms undergo fission, they give out few neutrons also (more than one) and they in turn help to fission other atoms, thus creating a chain reaction. The reactions are so fast that a few killograms of fissioning atoms can be used up within a fraction of a second. Each of these fissioning nuclei gives out enormous amount of energy and that energy is the source of a bomb or the manufactured electricity.

**Conclusion**

It is almost half a century that we have known nuclear reactions. But till now, only the gross results of different reactions have been explained with the help of model reaction mechanisms. The problem, in nuclear physics, comes up when one tries to explain the finer features of the results with a single model. There is no single consistent theory which can explain all the existing results of nuclear reactions. Presently, we are collecting information and may be we have to collect more data before we can give a correct picture of nuclei.

The obvious questions which

(*Continued on page 587*)

# SERVOMECHANISM
## principle and applications

RANJAN
CHAKRAVARTI

**It is a mechanical system which not only receives orders and carries out particular function, but also corrects errors.**

FROM the dawn of civilization, man has endeavoured to discover ways and means that will obey his commands and carry out jobs at his will. He has employed animals and invented devices to fulfil various needs of his life. To make life easier, man has also gone to the extent of enslaving his fellowmen. But with the progress of civilization he had to dispense with slavery and innovate alternatives to carry out drudgeries.

The word 'servomechanism' means a machine which serves as a slave, derived from the Greek word 'servo'. The function of servomechanism is to receive an order and to carry out the same. In the process of carrying out a command (input) received by the servomechanism, it automatically carries out necessary corrections (or "actuates") for any deviation from the exact way in which it has been given the command to do a particular job. These corrections are made regardless of the fact whether deviations are caused by outside forces or by errors within the mechanism.

In carrying out the command, a servomechanism basically does two operations :

(i) It first analyses and then determines the difference between (both in amount and in type) what is happening and what should actually happen in response to the command.

(ii) It then goes on to correct this difference—thus changing what is actually happening to what should happen.

Servomechanism, or servos for short, are part of a family of such systems known as feedback control systems. The fundamental requirements of a servomechanism are as follows:

A servomechanism should be able to :

(a) accept an order (or command) as its input which will define the desired output of the system; (b) analyse and evaluate existing conditions; (c) compare the existing conditions with the desired result and obtain a difference (or error) signal; (d) issue a corrected order based on the error signal, which will properly change the existing conditions so as to arrive at the desired result; and (e) have the means of carrying out the corrected order.

The operations of a simple servo may be explained as follows: A command signal is applied as the input which is compared instantaneously with the output. The result of such comparison (E) between input and output is amplified (i.e., raised to a higher level of power) and then the amplified signal is used to control a power device. The power device, in turn, amplifies the signal further and supplies still larger amount of power to the output or the load, which the servo is controlling. This output in itself may be a desired end-result, or in turn, it may be used as an input to another control system.

The system of simple servo has been represented by the block diagram given in Fig. 1. Such a diagram is more functional in nature rather than physical, in the sense that the blocks represent things or functions which are to be performed by the system rather than pieces of equipment. Such block diagrams are widely used to represent complicated systems in a simplified manner. Principle of servomechanism is widely utilized in various industrial and military applications. A few such examples are given here.

The arrangement for automatic room cooling is a simple example of application of servomechanism schematically represented in Fig. 2. When the switch (S) is closed manually, the cooler along with its blower motor is switched on and cool air enters into the room. The temperature inside the room is indicated by the thermometer T. To maintain temperature of the room within the desired range, the switch is required to be put off whenever thermometer reaches a pre-determined value of temperature $T_2$. Again, the switch has to be put on when the temperature of the room increases upto a certain desired value ($T_1$). Here the system does not respond to any change in the input conditions, i.e., switching 'on' and 'off' of the cooler is not automatically controlled by the temperature of the room. Such a

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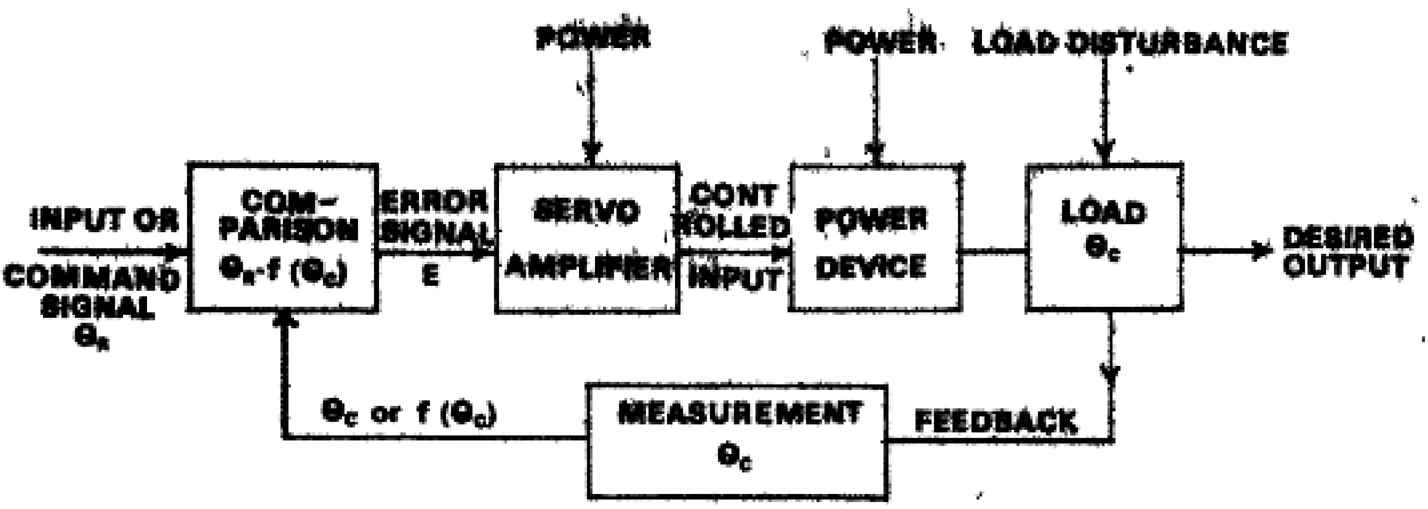

Fig. 1. Block diagram of a simple servo system

system where the output lacks response to any change in input conditions is called an open cycle servo system.

One way to maintain the temperature of the room between the predetermined temperatures of $T_1$ and $T_2$ is to introduce a human operator in the system who will put the switch off and on by keeping a watch on the thermometer readings. With the inclusion of such a human operator a feedback or follow-up has actually been introduced into the system of controlling the temperature of the room. Such a device is based on the principle of automatic or close-loop servo system.

The function of a human operator in any system (e.g., running a machine or driving a car, etc.) may initially seem to be quite complicated. However, on a close look, it will be noticed that in practice he is performing only a few distinctly interrelated functions to attain a desired result. His functions may be summarised as:

(a) to collect data on which he is to act through his senses like sight, hearing or touch and then; (b) take appropriate action for a desired result. Fig 3 represents the action of human operator by means of a simplified block diagram.

It may be observed that the human operator is primarily an error measuring device. To attain the desired result, the operator makes an assessment of the error involved and then determines steps to be taken so that the machine may use energy from an external source.

Fig. 4 shows an arrangement where the human operator is replaced by a device and we have a system to control temperature of a room automatically. In this example, the operator and the thermometer have been replaced by a sensing device. One simple example of such a sensing device is a thermostat which is a bi-metal strip comprised of two dissimilar conductors with different coefficients of thermal expansion. One end of each of the conductors is joined together, the other end being kept open. When the temperature increases on account of dissimilar coefficient of thermal expansion, the strips on the open end bend away from one contact of the electrical circuit and move to another contact.

In this example, when the temperature of the room increases, the conductors of the thermostat get heated and the strips bend and move towards the contact connecting the electrical circuit to a source of power supply, which in turn switches on the cooler along with the blower motor.

Once the cooler runs for sometime, the temperature of the room lowers down to a pre-determined temperature $T_2$. With reduction of temperature there is a contraction of the thermostat conductor strips and they move away from the "On Contact" to the "Off Contact" of the electrical circuit. Consequently, the cooler is switched off.

This cycle of switching on and off of the cooler is repeated over and over again automatically maintaining the temperature of the room between $T_1$ and $T_2$. The bending of thermostat strips can be so adjusted (as indicated by a setting dial) that it touches (or makes) the electrical 'on' contact when the room temperature reaches the pre-determined highest temperature $T_1$ and leaves (or breaks) the electrical contact when room temperature reaches

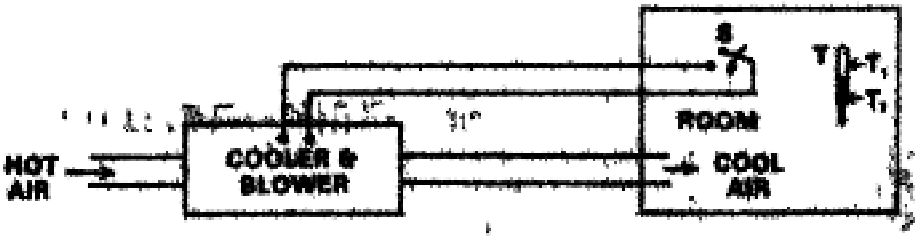

Fig. 2. Automatic room cooling : open cycle control system

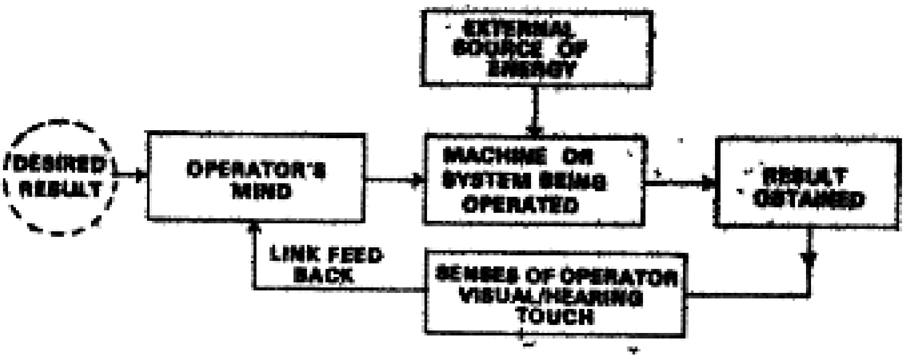
EXTERNAL SOURCE OF ENERGY
DESIRED RESULT
OPERATOR'S MIND
MACHINE OR SYSTEM BEING OPERATED
RESULT OBTAINED
LINK FEED BACK
SENSES OF OPERATOR VISUAL/HEARING TOUCH

**Fig. 3. Action of a human operator**

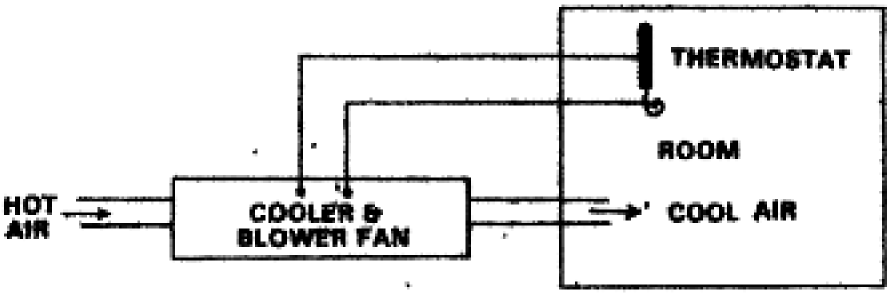

**Fig. 4. Automatic room cooling: closed cycle control system**

the pre-determined lowest value $T_2$ and thus switches 'off' the source of power.

In this example, we have a system of control where the input is automatically regulated to have a desired output by utilizing the basic principles of a closed-loop servomechanism. Fig. 5 represents the system in block diagram.

The following components are indicated in the block diagram (Fig. 5):

(i) The load is represented by the room air cooled by the cooler and blower fan and the sensed state is the temperature inside the room;

(ii) The bimetal strips of the thermostat act as a transducer or a sensor device by sensing the temperature of the room.

(iii) At any point of time, the error is established as the difference between manual setting of the thermostat and the actual room temperature. The manual setting of the thermostat therefore acts as a set-point, or reference signal, and the error signal is determined by sensing the point when the room temperature is below the manual setting ;

(iv) Since the heavy current to the cooler motor passes through the relay contacts bypassing the thermostat, the relay acts as an amplifier; and

(v) The cooler motor along with the blower fan supply the plant for manipulating the load (i.e., cooled air).

Consider now a typical military application of the principle of servomechanism: an anti-aircraft gun has to be accurate while firing at a target. Such a control system is represented in a generalised manner in Fig. 6. The gun on its mounting is to be rotated so that its angle with the horizon (angle $\theta_o$) corresponds to that of a controlling shaft (angle $\theta_i$) as determined by the input. The load is driven by an electric motor (usually called a servomotor) which derives its energy from an external source and is controlled through an amplifier. The angular position of input and output shafts, as compared with an error signal proportional to the difference between them, is used as a controlling input to the amplifier. The direction of rotation of this servo motor is such that it will tempt to reduce any error, i.e., to say it tries to drive the output shaft into alignment with the input shaft. In this arrangement, consider that a human operator has been replaced by a mechanical or electrical error measuring device. The similarity will be complete if the amplifier-servo motor system is simply regarded as a mechanism which produces a torque (T) on the output shaft which is K times the error E. The higher the gain of the amplifier, the larger is the coefficient K. This is an example of application of close-loop servomecha-

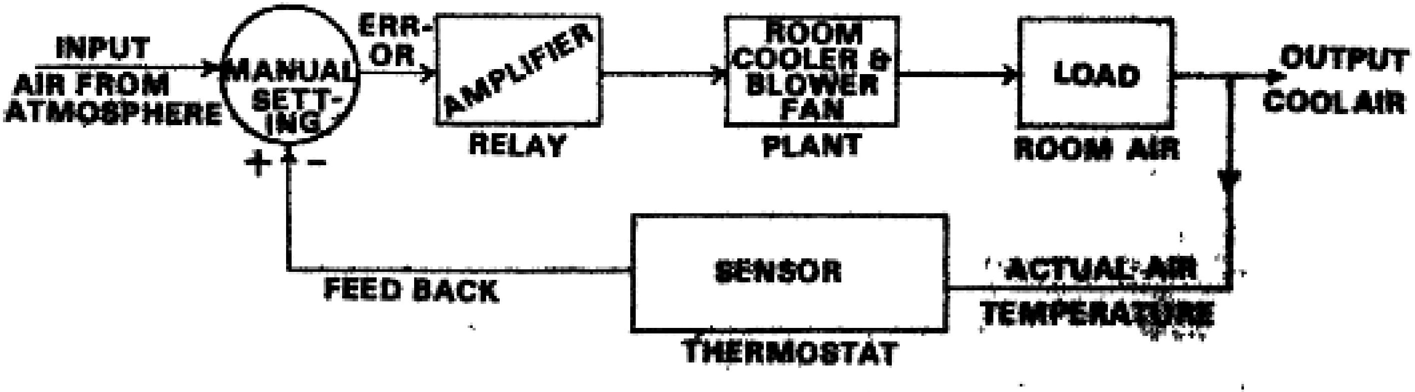

**Fig. 5. Block diagram of automatic room cooling : closed cycle control system**

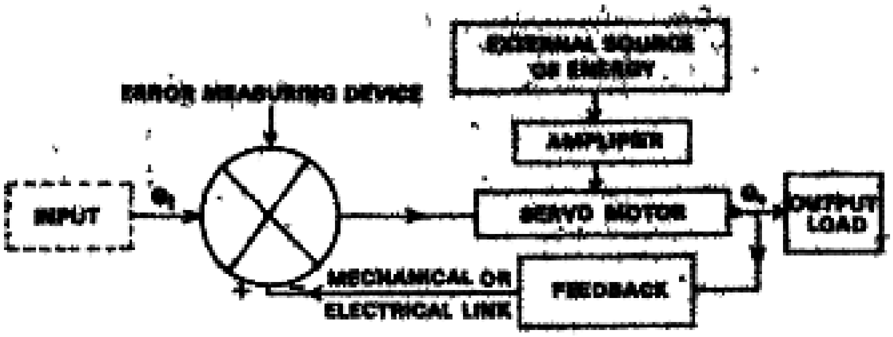

Fig. 6. Application of servomechanism to control angular position

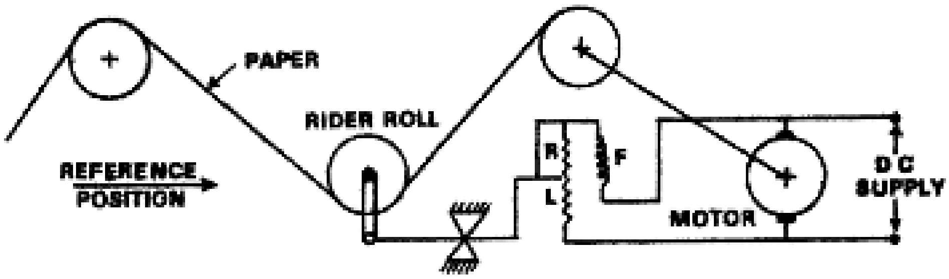

Fig. 7. Tension control for a paper reel device

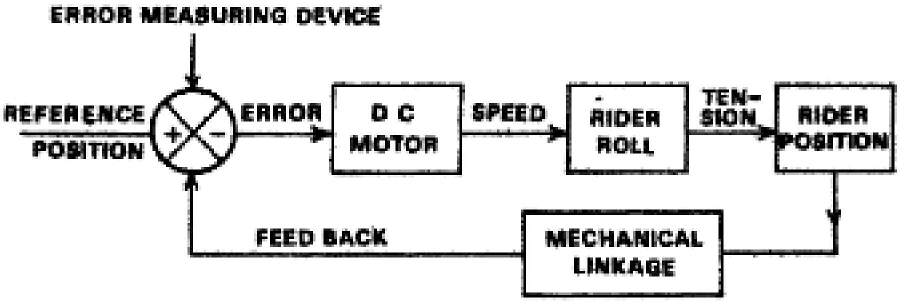

Fig. 8. Block diagram of a paper reel drive tension control

nism, the main characteristics being an error determining device which compares the input and output quantities and controls through some machine the flow of energy from an external source to the load. In particular, little or no energy is taken from the device which supplies the input signal. Here the input is quite incapable of supplying the power necessary to move the heavy gun. That is why it is not possible simply to connect the input shaft to the gun mounting. Another feature to be noticed is that there is a close-loop or a closed sequence of dependence of the various quantities with each other. This gives rise to alternative names for a servomechanism: closed loop, closed sequence or closed cycle system.

Another example of application of servomechanism in controlling industrial manufacturing process is a tension control device for a paper reel drive mechanism in manufacture of certain types of papers. The paper sheet has to be continuous and must be rolled on a central tube to obtain a compact and uniform reel. The paper must also be pulled on to the reel at a constant magnitude of tension. If the tension increases, the paper tears off, while reduced tension produces a loose roll. Control of the tension is thus of vital importance.

The diameter of the roll increases as layers of paper run on to the reel. If speed of the reel remained constant, the linear velocity of the paper would increase, which would increase the tension in the paper. Hence, by adjusting the reel speed the tension control may be obtained. Fig. 7 shows in a simple schematic form a scheme which is commonly used in controlling tension for a paper reel drive.

The desired tension is set by means of a Rider-roll under which the paper strip passes. The Rider is constrained to a vertical movement only and the magnitude of the tension depends on the weight of the Rider-roll and also on any spring loading which may be used in addition. Since the paper tension effectively supports the Rider, any variation in tension makes the Rider move in a vertical direction—upward for increased tension and downward for decreased tension.

The vertical movement of the Rider is utilized to control the speed of the direct current drive motor by changing its field current. The change in the speed of the motor, in turn, makes suitable adjustments in the tension of the motor. If the tension in the paper increases beyond the desired limit, the Rider is raised. A suitable lever connection (L) then reduces the resistance (R) in field (F) of the direct current motor. The field current of the motor increases reducing the speed of the motor which consequently decreases the tension of the paper.

The simplified block diagram of such a tension control system is shown in Fig. 8. The motor may be considered as a single device and represented by a single block. For the sake of clarity, the output of the system is shown as three separate blocks instead of one. The reference position is the 'desired' Rider position, and the feedback signal is the 'actual' Rider position. The 'error' detector is the mechanical link

(*Continued on page 587*)

U. C. LAVANIA

# Chromosome banding technique allows visualisation of molecular sequences of chromosomal DNA at the cellular vis-a-vis microscopic level

THE typical cell nucleus contains a small, well defined organelle, the nucleolus. But the bulk of the nucleus appears to be an otherwise structureless mass of tiny dots and threads more or less uniformly dispersed in the nuclear sap. At the onset of mitosis (cell division during growth), the dots and threads resolve themselves into elongate chromosomes, which gradually condense to form compact bodies grouped in the centre of the cell. Towards the telophase stage (last stage) of the division cycle, the condensation process is reversed, the chromosomes gradually unravel to form new nuclei By carefully following chromosomes through division cycle it has been proved that the puzzling structures which stain densely in the nucleus are simply specific chromosomes or chromosome regions that do not unravel like the rest of the chromosome material during formation of new nuclei Two classes of chromosome material have been recognised, the euchromatin, which undergoes a typical cycle of condensation and unravelling, and the heterochromatin, which maintains its compactness in the nucleus. In individual chromosomes, heterochromatin frequently occurs in large blocks or segments, but these may be interrupted by pieces of euchromatin and, conversely, small bits of heterochromatin may occur in euchromatin.

Recent advances in molecular hybridization have aided in unravelling the functionally different segments in a eukaryotic chromosome. The localization of such different functional segments at cytological level was previously confined to only the giant salivary gland chromosomes of dipteran larva (e g , *Drosophila*, *Chironomus*, etc.), a rather unusual structure in the life cycle of an organism. Here the chromosomes are marked by densely staining structures, called bands, which are separated by very weakly staining gaps, or interbands. The characteristic banding patterns have permitted exact identification of each small segment of the chromosome. The techniques of molecular hybridization have opened up new possibility of locating such functional regions of chromosomes and of determining the sequence complexity of DNA in different biological systems.

Chromosome banding technique, as it stands today, has revolutionized cytogenetics. It has made possible precise identification of individual chromosomes or even parts of chromosomes, their structural and molecular organization, chromosome changes during evolution, studies in chromosome polymorphism, detection of structural karyotypic changes, genome analysis in allopolyploids, aneuploid identification and detection of interspecific translocations.

Recent developments in techniques for linear differentiation of chromosomes have given a new insight into the problem of chromatin organisation at cytological level. The oldest known among the techniques useful for differentiating between euchromatin and heterochromatin is based on 'cold starvation' effect where the heterochromatic regions on chromosomes appear faintly stained after a relatively extended period of cold treatment. These weakly stained segments or gaps were called "special segments or H-segments" by Darlington and La Cour (1940).

## Q-banding

A breakthrough in development

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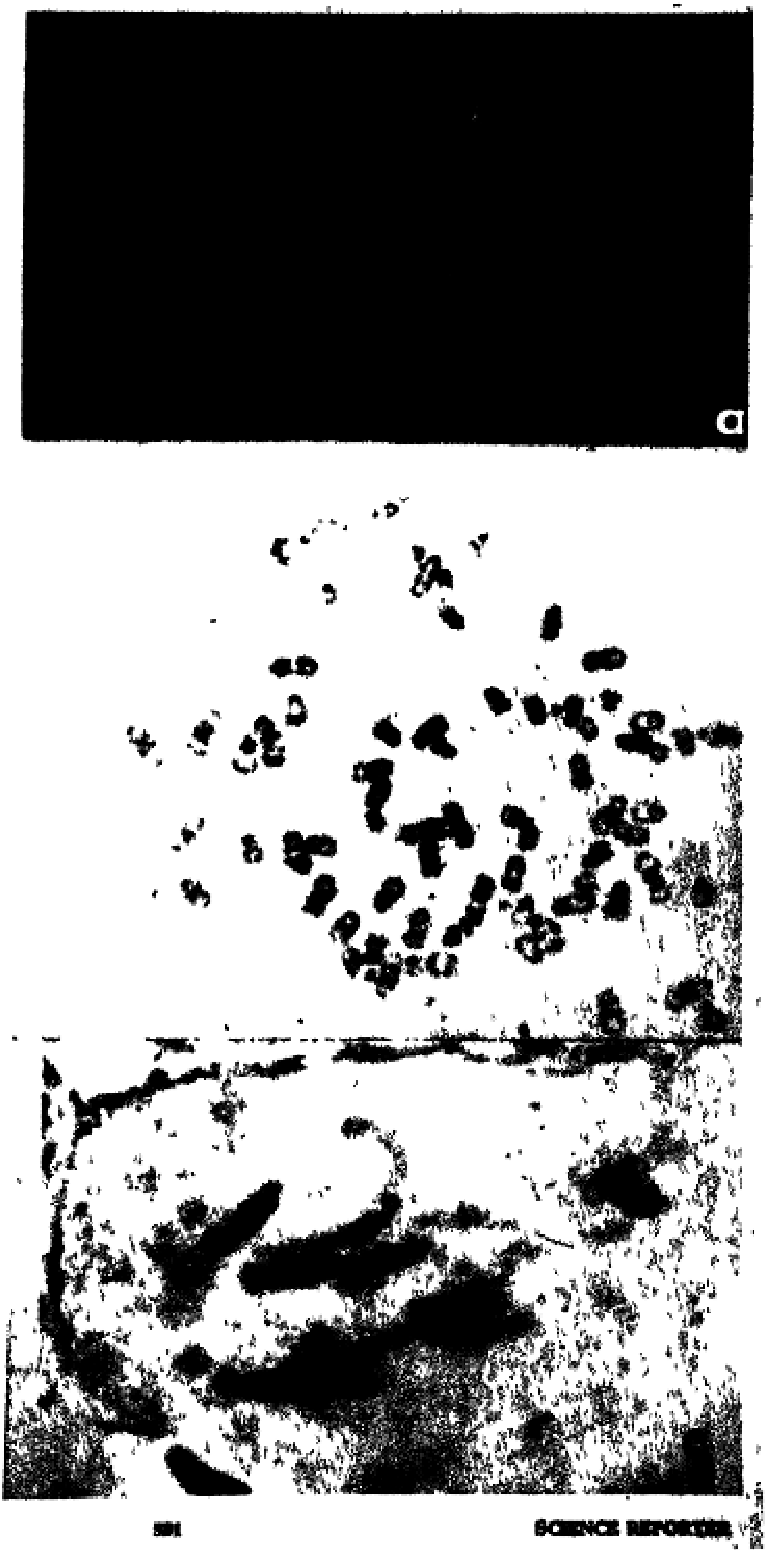


Fig. 1. (a) Q-bands of *Allium pulchellum* (taken from C. G. Vosa; *The Nucleus*; 20; 23-41 (1977)); (b) G-bands of Mouse Ascites culture (*Courtesy* : Dr. S. Ghosh; Calcutta University); (c) Giemsa C-bands of *Vicia faba* (author; unpublished)

of the technique of banding chromosomes came from the pioneering studies of Caspersson *et al.* (1968) at Karolinska Institute, Sweden. Using DNA binding fluorochrome dyes such as quinacrine mustard (QM) and quinacrine dihydrochloride, they suggested selective, discrete labelling of plant and animal chromosomes. When observed under fluorescence microscope after treatment with QM, chromsomses exhibit bands of fluorescence. The brightly fluorescing regions or segments are called Q-bands. Similar banding patterns are observed when QM is replaced by 'Hoechst 33258' dye.

Various other fluorochrome dyes have been reported to give banding patterns. Some of them like ethidium bromide gives banding which is the reverse of quinacrine patterns, i.e., reduced fluorescence at the same places where QM gives enhanced fluorescence. Other fluorescent dyes occasionally used are sarcolysinoacridine, berberine sulphate, 2-7-di-*t*-butyl proflavin and even alcoholic extracts of alkaloids from roots of some papavaraceous genera.

Studies of C. G. Vosa of Botany School, Oxford (*Chromosoma*, 30 : 366-372, 1970) suggested for the first time, the classification of four main types of heterochromatin as defined by allocyclic DNA, namely :

(a) detectable by 'cold starvation' effect and showing enhanced fluorescence (*Trillium* and *Vicia faba* type);

(b) same as (a) but with reduced fluorescence (*Tulbaghia* type);

(c) not revealed by chilling and showing enhanced fluorescence (*Allium carinatum* type); and

(d) same as (c) but with reduced fluorescence (*Scilla sibirica* and *Allium cepa* type).

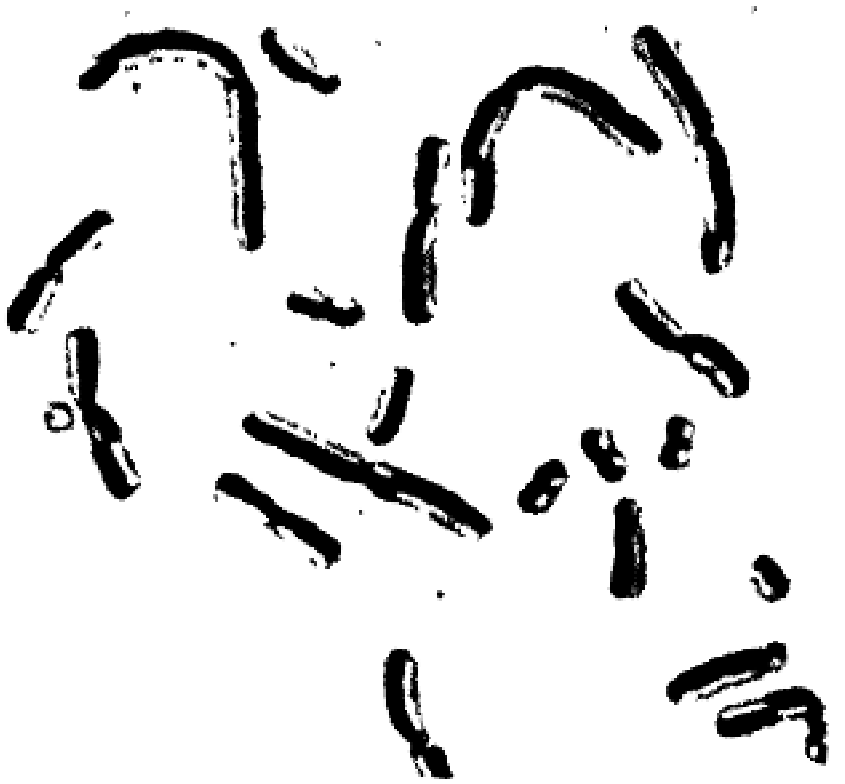


**Fig. 2. Chinese hamster chromosomes showing differential staining of sister chromatids (taken from S. Takayama & S. Sakanishi, *Chromosoma*, 64; 108-115, 1977)**

## C-banding

Following *in situ* hybridization of mouse satellite DNA with complimentary RNA, M. L. Pardue and J. G. Gall of Department of Genetics, University of Edinburgh and Department of Biology, Yale Univesity, reported that centromeric heterochromatin could be detected with Giemsa stain by its denser stainability (*Science*, **168**: 1356-1358, 1970). This led to the development of the C-band technique for detection of repetitive DNA which is richly localised in the centromeric regions (on either sides around the centromere) of chromosomes (Arrighi, F. E. and Hsu, T. C., *Cytogenetics*, 10 : 81-86, 1971). In C-band technique, air dried chromosome preparations are treated with alkali (e.g., saturated solution of Ba (OH)$_2$for 5 minutes (denaturation) followed by renaturation in 2×SSC (0.3M NaCl+0.03M Na citrate) for 1-2 hrs. at 60°C, and subsequently stained with diluted solution of Giemsa in phosphate buffer. The technique produces dark bands at the centromeric regions of chromosomes and over areas of "constitutive heterochromatin." These are called C-bands. One very important difference in the Giemsa method is that it does not discriminate between segments with intense and reduced fluorescence, but stains both in the same way. This method, besides centromeric bands, also gives bands on the chromosome arms in plant systems.

## G-banding

Giemsa stained bands obtained after saline treatment in intercalary segments of chromosomes are referred to as G-bands (Drets, M. E. and Shaw, M. M., *Proc. natl. Acad. Sci.* (USA), **68** : 2073, 1971). G-banding patterns have been obtained following a variety of treatments such as standard saline, NaOH/HCl prior to SSC, trypsin, etc. The technique is confined mainly to animal systems.

## R-banding

A different method of Giemsa staining of air-dried preparations of animal chromosomes after controlled incubation at 87° C in phosphate buffer for 10-12 minutes, produces paler staining regions which are easily visible under phase contrast microscope. (Dutrillaux, B. and Lejeune, J., *C. R. Acad. Sci. Paris.*, **272** : 2638-2640, 1971). The banding patterns are reverse to that obtained for G-banding.

Some DNA binding G-C specific antibiotics, e.g., Chromomycin A3, Mithramycin, Olivomycin, have also been found to produce fluorescence bands similar to R-banding patterns when applied to air dried chromosome preparations and viewed under fluorescence microscope.

## O-banding

A new banding technique termed O-banding has been developed by Professor A. K. Sharma (1975, 1977) of Botany Department, Calcutta University and pursued by the present author. It is especially suited to plant chromosomes with Orcein staining. The procedure involves pretreatment of root tips in suitable pretreating agent, fixation in acetic ethanol, treatment in a mixture of sodium chloride (1*M*) and sodium citrate (0.1 *M*) for 2-2$\frac{1}{2}$ hrs at 27°C-28°C, staining in aceto-orcein mixture and squashing in 45% acetic acid. Similar effect is also observed if salt treatment is replaced by trypsin treatment at low temperature. O-bands appear on both sides of centromere similar to C-bands as well as on intercalary segments similar to G-bands depending on the period and concentration of salt treatment.

## Other methods

Through minor changes in the above mentioned banding techniques many simplified techniques have been discovered which led to the proliferation of banding nomenclature, viz; *T-banding* (staining terminal regions of chromosome—the terminal bands or T-bands), *N-banding* (staining nucleolar organizer regions), *Pericentric chromosome banding* (for staining pericentric chromosome bands in plants), *Cd-banding* (revealing two identical dots at the centromere, one on each chromatid—the centromeric dots *Cd*), *Hy-banding* (for preferentially staining heterochromatic segments in somatic chromosomes using HCL).

## Differential staining of sister chromatids

Though the theme of the article is focussed on linear differentiation of chromosome, it becomes imperative to deal with recent developments in lateral differentiation of chromosomes which have proved useful in the differential staining of sister chromatids.

Techniques have been developed where "Hoechst 33258" is combined with Giemsa staining (fluorescent plus Giemsa or FPG) to make permanent Giemsa stained cytological preparations of differentially labelled chromatids. The techniques are useful for the study of sister chromatid exchanges. The method developed by P. Perry and S. Wolff of MRC Clinical and Population Cytogenetic Unit, Western General Hospital, Edinburgh, and Laboratory of Radiobiology and Department of Anatomy, University of California (*Nature*, 251 : 156-158, 1974) for animal materials involves growing cells in a solution of BrdU (Bromodeoxyuridine) for two rounds of DNA synthetic phase, followed by proper pretreatment for chromosome analysis and then fixing them in suitable fixative. Air dried preparations of the mateial are stained in "Hoechst 33258" aqueous solution and processed as usual for observation in a fluorescence microscope. Sister chromatids fluoresce differentially.

## Mechanisms of chromosome banding

On the basis of banding patterns and other observations there are three major types of chromatin : centromeric constitutive heterochromatin, corresponding to C-bands; intercalary heterochromatin, generally corresponding to G-bands; and euchromatin, corresponding to interbands or R-bands.

Experiments with acid-treated chromosomes indicate that non-histone rather than histone proteins are primarily involved in banding. The heterochromatic segments are thought to consist of repetitive sequences of DNA composed exclusively of AT or GC nucleotides, or of repetitive sequences where the relative proportions of AT : GC may be biased either way in various patterns. It has been proposed that Q-banding is due to a difference in base composition of DNA along the chromosome. AT-base pair sequences enhance Q-fluorescence whereas GC-base pairs effectively quench it. Thus Q-fluorescence may be used for the detection of AT-rich or GC-rich chromosome regions. The weight of evidnece, however, suggests that both Q- and G-bands are the result of dye binding to adjacent sites on folded molecules of native DNA, the appropriate conditions necessary for such binding depending to a great extent on the relationship between DNA and its associated non-histone proteins. The major factor in C-banding appears to be the presence of non-histone proteins that bind specifically to centromeric heterochromatin and protect it from extraction by barium hydroxide and salts. This results in intense staining of C-bands and poor staining of the rest of the chromosome. Furthermore, it has been suggested that $Ba(OH)_2$ alters the chemical structure of heterochromatin, rendering it insoluble in SSC. The importance of DNA protein linkage, as in C- and G-banding, is noted in Orcein-banding as well. Gradual removal of non-histone proteins is principally responsible for O-banding.

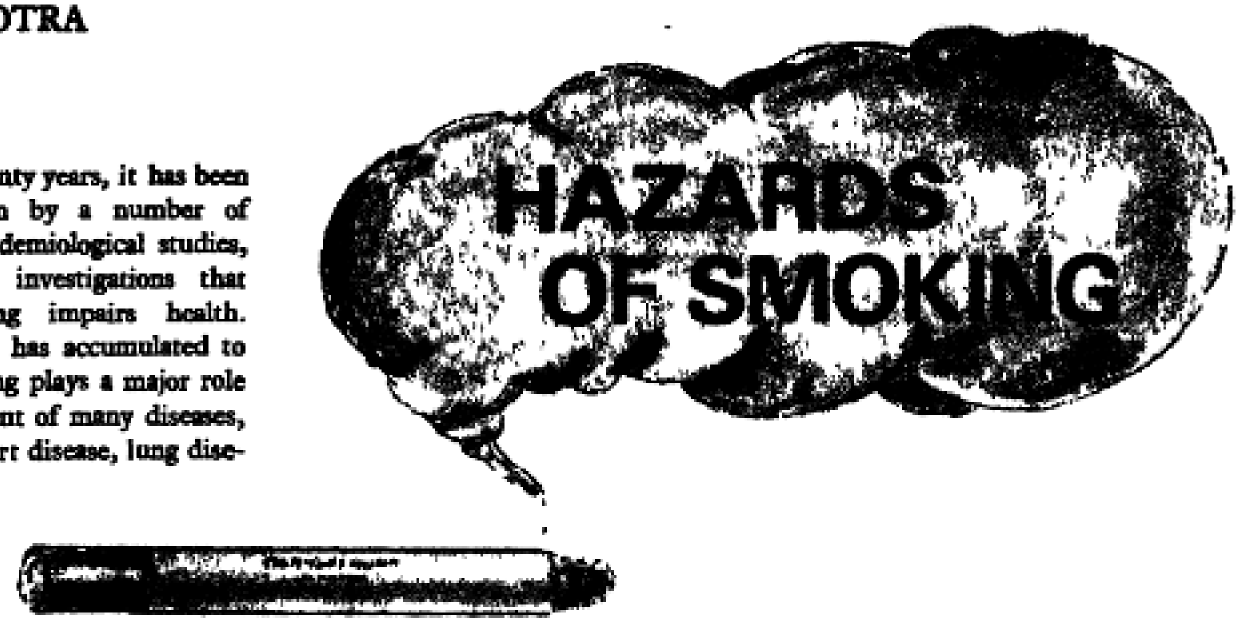
The mechanism involved in the differential staining of sister chromatids by FPG technique is that replacement of thymine in chromosomal DNA with BrdU strongly reduces the fluorescence of fluorochrome dyes.

## Further reading

1. Caspersson, T. and Zech, L. (Eds.), *Chromosome Identification*, Nobel Symposium, 23, 1973, Academic Press.
2. Hecht, F., Wyandt, H. E. and Magenis, R.E.H., The Human Cell Nucleus : Quinacrine and other differential stains in the study of chromatin and chromosomes. In *The Cell Nucleus*, 2: 33-121, 1974, (Ed.) H Busch, Academic Press.
3. Kato, H., Spontaneous and induced sister chromatid exchanges as revealed by BUdR-labelling method., *Int. Rev. Cytol*, 49 : 55-97, 1977.
4. Lavania, U.C., Differential staining and plant chromosomes—A progress in cytogenetics, *Curr. Sci.*, 47 : 255-260, 1978.
5. Sharma, A. K., Chromosome banding and repeated DNA, *J. Indian bot. Soc.*, 54 : 1-8, 1975.
6. Wolff, S., Sister chromatid exchange, *Ann. Rev. Genet.*, 11 : 183-201, 1977.

**RAJ MEHROTRA**

# HAZARDS OF SMOKING



IN the past twenty years, it has been clearly shown by a number of clinical and epidemiological studies, and laboratory investigations that cigarette smoking impairs health. Enough evidence has accumulated to show that smoking plays a major role in the development of many diseases, like ischemic heart disease, lung disease, chronic bronchitis and emphysema. It has increased the overall mortality and morbidity.

Effects of smoking become manifest after several years of smoking and are not often ascribed to this habit. Several theories have been put forward to explain the mechanism by which smoking leads to ill health. Cigarette smoking starts a disease process that progressively produces an irreversible damage, the end effect of which is more or less proportional to the total dose accumulated during years of smoking. It is characterised by continual repair and recovery, until a critical point is reached when the process becomes irreversible. The total effect is cumulative, i.e., several short periods of heavy smoking could lead to the point of irreversibility. The other view is that it promotes rather than starts a disease process; it acts either directly by supporting a developing pathological condition or by diminishing body's normal defence mechanism. It has also been suggested that smoking induces a temporary condition favouring a critical combination of events which leads to disability. disease and possibly fatal consequences. There is the view that smoking may be related to excess disability or death because of a close association with some other condition.

In recent years, a number of reports of large prospective studies have appeared in literature regarding smoking habits and total mortality. They demonstrate that cigarette smokers taken as a whole have an approximately 30% to 80% greater mortality that non-smokers. The mortality increases with increased tobacco consumption. The excess mortality is greater in those who start smoking at an earlier age and inhale the smoke. Only one large prospective study has included women and has shown that excess mortality in female smokers was rather less than that in males. This may be because women tend to start smoking later in life, smoke less, and inhale less.

Excess mortality in smokers is due to the increased incidence of several diseases but about 80% of the increase is due to lung cancer, bronchitis and emphysema, ischemic heart disease and other diseases of the vascular system. Excess mortality of cigarette smokers is also related to their smoking habits—to the number of cigarettes smoked, age of starting smoking, and the habit of inhalation.

**Smoking is a scourge that kills or maims millions every year**

### Specific disorders related to smoking: Lung cancer

F. H. Muller of German Cancer Institute, Berlin in 1939 first drew attention to the relationship between lung cancer and heavy smoking. This was later confirmed by several investigations and statistical surveys. It has been shown that the risk of development of lung cancer increases directly to the number of cigarettes smoked. In heavy smokers it is 15 to 30 times more than in non-smokers The risk also increases by increased inhalation, by early habit of smoking and keeping the cigarette in the mouth between the puffs and by relighting half-smoked cigarettes Apart from statistical evidences, the association between smoking and lung cancer rests on the finding that the cigarette smoke contains benzo (a) pyrine and

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other carcinogenic substances together with traces of arsenic which volatilizes as arsenous oxide and radioactive polonium compounds. They have been used successfully in experimental production of tumours in animals.

In several autopsy studies, it has been found that cigarette smokers show extensive metaplastic changes (change in the morphology of cells) in the bronchi including precancerous changes where the severity can be related to the number of cigarettes smoked. These changes are extensive in patients with lung cancer, while they are less frequent in non-smokers and ex-smokers.

The retrospective and prospective studies in United Kingdom have shown a reduced risk of lung cancer in those who stop smoking. There is a small increase in lung cancer mortality in men who have smoked pipes and cigars. It is not known why thus form of smoking should have so little effect, although the amount of carcinogen is much greater in pipe and cigar smoke than in cigarettes. The most accepted among the explanations put forward is that a high proportion of cigarette smokers smoke heavily and inhale deeply, while pipe and cigar smokers are mostly moderate smokers and do not inhale deep. On the other hand, three retrospective studies in Switzerland and Germany have shown that the risk of lung cancer in pipe and cigar smokers is as great as in cigtaette smokers.

Experiments have been carried out in an attempt to show that tobacco smoke contains cancer initiating (carcinogenic) and cancer promoting (cocarcinogenic) substances. Cancer can be readily induced in the skin of experimental animals by the application of condensates from tobacco smoke. The major volatile cillotoxic agents of the smoke have been shown to play a role in inhibiting lung clearance mechanism, and indirectly contribute to the induction of lung tumours. In addition, the gas phase of smoke contains major toxic agents like nitrogen oxide, ammonia and aldehyde, all of which contribute to the carcinogenecity of the smoke. Lung cancers are the result of repeated exposures of the bronchial epithelium to smoke containing both cancer initiators and cancer promoters.

Cigarette smoking is especially dangerous to people exposed to coal smoke, and those with certain occupations involving exposure to asbestos dust, chromates, nickel, arsenic, radioactive materials, etc., have been shown to have a greater risk of lung cancer than non-smokers.

Individual susceptibility of a cigarette smoker to lung cancer may vary. It is possible that there may be some predisposing characteristics for developing this disease, which if detected, may permit identification of high risk smokers. Recently interest has been focussed on a cellular enzyme aryl hydrocarbon hydroxylase (AHH) isolated from pulmonary macrophages and lymphocytes. It metabolizes polycyclic hydrocarbon with the production of highly carcinogenic metabolites. It has been shown that the activity of AHH can be increased in both humans and experimental animals by exposure to cigarette smoke. The difference between individuals in AHH activity appears to be of genetic origin. In a study of 50 patients with lung cancer, about 30% had high and 60% medium AHH levels while in 131 controls only 9% had high and 46% medium levels. It is therefore possible that among smokers there will be some with a greater proneness to lung cancer. Further studies are needed in this direction.

## Bronchitis and emphysema

A number of prospective studies show a high prevalence of cough and expectoration in smokers and its close relationship to the number of cigarettes smoked. The symptoms usually abate rapidly in those who stop smoking. There are recurrent episodes of respiratory tract infection due to excess mucus production in cigarette smokers than in non-smokers. On clinical examination every aspect of pulmonary function has been shown to be less efficient in cigarette smokers than in non-smokers of the same age group. The chief abnormality is the progressive narrowing of the pulmonary airways leading to impairment of gas transfer and hypoxia. Patients with severe airway obstructions who stop smoking find an improvement in cough and breathlessness, but if bronchitis or emphysema (over-distention of lung) as advanced too much, the damage is irreversible.

Mechanism by which smoking produces bronchitis and emphesema is now well established. Irritant substances, both in the gaseous and particulate phase of the smoke, are responsible for immediate coughing and bronchoconstriction. These substances are also responsible for hypertrophy (increase in size) of the mucus glands. Excessive mucus and ciliostasis (damage of the cilia of the respiratory epithelium) impairs normal defence mechanism of the lung and predisposes recurrent bronchial infection. It is, however, not known which substances in cigarette smoke are responsible for irreversible bronchial narrowing and alveolar (air sacs of lung) destruction leading to emphysema. Experimental animals exposed to tobacco smoke have been found to develop changes similar to those found in smokers with severe bronchitis.

## Ischemic heart diseases

A well-recognised correlation exists between cigarette smoking and death from ischemic heart disease. E. C. Hammond from University of California in 1972 first produced data from a prospective study showing that men aged 40-50 who smoke more than 40 cigarettes a day run a five times greater risk of dying of ischemic heart disease than a non-smoker. British data show that smoking more than 15 cigarettes a day trebles the risk of dying from ischemic heart disease in men aged 45 to 55. Similar results have also been obtained in Framingham study and in a joint prospective study carried out in Albany and Framingham in U.S.A. These studies clearly indicate that mortality from ischemic heart disease increases with increase in cigarette smoking in those who inhale and in those who start smoking at an early age, and is lower in smokers who stop smoking than in those who continue. In women, specially before the age of 65, death rates from ischemic heart disease are much lower than in men, but the proportionate effect of cigarette smoking is similar to that seen in men.

Prospective studies in different countries have shown that the incidence of non-fatal attacks of ischemic heart disease and angina pectoris are closely related to the smoking habits. Angina pectoris has been found to be more frequent in cigarette smokers than in non-smokers. The frequency and severity of atheroma (fat deposits in arterial wall) of the coronary arteries has also been found to be positively related to previous cigarette smoking as evidenced in autopsy.

The mechanism by which cigarette smoking effects heart has been studied in great detail in the last decade. It has been shown to (promote release of catecholamines from adrenal glands which in turn increase platelets adhesiveness promoting a liability to thrombosis), raise plasma levels of free fatty acids which promote formation of atheromas, and increase liability of cardiac arrhythmias which may lead to sudden death. Catecholamines are responsible for tachycardia, increased cardiac output, and slight hypertension that occur in smokers. This may not definitely impair the efficiency of a normal heart, but impairs oxygen supply to ischemic heart muscle to a critical degree.

Cigarette smoke contains a high concentration of carbon monoxide (1%-5%) in the gaseous phase of smoke. Concentration varies with burning temperature of cigarette, porosity of the paper, etc. Carboxyhaemoglobin level in smokers varies from 2% to 15% depending upon the amount smoked, degree of inhalation, time elapsed since the last cigarette was smoked. Carbon monoxide has a much greater affinity for haemoglobin than oxygen. It impairs oxygen transport in two ways, first it competes with oxygen for haemoglobin binding sites, and second, it increases the affinity of remaining haemoglobin for oxygen so that in a given time a smaller amount of oxygen is released to the tissues. The pathophysiological studies in man and animal experimental studies together with epidemiological data point to the conclusion that cigarette smoking is an important cause of an increased risk of ischemic heart disease contributing both to the atherosclerotic process itself and to the condition that precipitates a heart attack and leads to fatal outcome. In young people, ischemic disease of the leg (thrombo angitis obliterans) causing intermittent claudicatium is confined almost exclusively to those who smoke.

## Smoking and pregnancy

Babies born to mothers who smoke during pregnancy have been shown to weigh less than those of non-smoking mothers. The extent of lower birth weight is directly related to the number of cigarettes smoked during pregnancy. Head circumference and crown-heal length are effected indicating that smoking restricts intra-uterine growth. Mothers who smoke heavily during pregnancy have been shown to have an increased risk of spontaneous abortion, preterm delivery, perinatal death, and even a possible long term harmful effect on physical growth, neurological development, and intellectual functions of the new born. It is not known how maternal smoking effects the foetus. It is thought that nicotine might reduce placental blood flow and that carboxy-haemoglobinaemia may also be harmful to foetus.

## Other conditions related to cigarette smoking

A large number of prospective studies have shown that several diseases like peptic ulcer, cancer of mouth, larynx, and oesophagus are more common with cigarette, pipe and cigar smoking. There are recent evidences of an increased risk of cancer of the pancreas, papillomata and bladder cancer in smokers

It may be concluded that smoking is a curse to mankind. For healthy, happy and prosperous life, no man should yield to the temptation of smoking.

## Further reading

1. Royal College of Physicians (1971); *Smoking and Health Now*, London, Pitman, Medical.
2. U.S. Department of Health Education and Welfare; *The Health Consequences of Smoking*, *DHEW* Publication No. 73, 8704 (1973).
3. U.S. Department of Health, Education and Welfare, 1968, *The Health Consequencies of Smoking*, A Public Health Service Review, 1967, Washington, D.C. (Public Health Service Publication No. 1696 revised Jan. 1968).

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## LETTERS (*Continued from page 570*)

2. Ferreira, S. H., Moncade, S., and Vane, J. R., Indomethacin and aspirin abolish prostaglandin release from the spleen. *Nature, New Biol.*, 1971, 232, 237-239.

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### Amoeba

Sir, I liked the poem **Amoeba** (*S.R.*, May 1980) by S. D. Mahajan. Please publish such poems on other topics, because it provides an interesting way to learn.

DEEPAK AHIR
*C-14, MLA Qrs.*
*Simla (H.P.)*

### Science quiz

Sir, This is to point out an error in **Science quiz** (*S.R.* May 1980). Question 7 says, "The only person ever to be honoured twice with the Nobel Prize in science is. .", to which the answer is Marie Curie. However, another scientist, John Bardeen of the U.S.A., has also won the Nobel Prize twice, having shared the Physics prize in 1956 for his work on transistors, and then having ing again shared the 1972 Physics prize for his work on superconductivity. In fact, he is the only person to have won the Nobel Prize in the same subject twice, as Marie Curie had one prize in Physics (1903) and the other in Chemistry (1911).

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## SERVOMECHANISM (*Continued from page 579*)

(in this example, the lever) between the Rider and the field resistance of the motor and the 'error' is the mechanical displacement produced by this linkage. It is to be noted that there is a feedback of energy from output to input which makes the system a closed-loop servo system.

In engineering industries components are required to be machined to stringent dimensional accuracy. To achieve such degree of precision, the various movements of cutting tools, etc., of the operating machines are increasingly being controlled by electrical or hydraulic circuits which utilise the principles of closed loop servo mechanism.

### Further reading

1. Thaler, George J., *Elements of Servomechanism Theory*. McGraw Hill Book Co. Inc. (1955).
2. Taylor, P. L., *Servomechanism—An introduction to the practice & theory of closed-loop position-control systems, with an account of methods of data transmission and computation*, Longman.
3. Ahrendt, W. R. and Savant Jr., C. J.; *Servomechanism Practice*, McGraw Hill Book Co. Inc. (1960).
4. Valkenburgh, Van, *Basic Synchros and Servomechanisms Pt. I & Pt. II*, Nooger & Neville, Inc.
5. Bowes, John L. and Chchutheiss, Peter M., *Introduction to the Design of Servomechanisms*, John Wiley & Sons Inc. (1961).
6. Zeines, Ben, *Servomechanism Fundamentals*, McGraw Hill Book Co. Inc.
7. Baeck, H.S., *Practical Servomechanism Design*, McGraw Hill Book Co.

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## NUCLEAR REACTIONS (*Continued from page 575*)

remain to be answered about nuclear reactions are many. For example, what is the path of evolution between two interacting nuclei? Is it like two liquid drops interacting with one another? Can we drill a hole in the nucleus? If we do so, how will the nucleus react ? How does a fat nucleus undergo fission? Does it first deform itself, elongate and then break apart ? Can the nuclear matter be compressed even if it is of so high a density? Many suggestions have been made by scientists but we have no way, as yet, to find out if they are correct or not.

### Further reading

1. Agarwal, S. K., D.Sc. Thesis, n°2215, University of Paris-Sud, 91406 Orsay, France.
2. Agarwal, S. K., *S.R.*, Dec. 1974.
3. Lefort, M., *Rep. Prog. Phys.*, 1976, 39, 129-173.

# EXPERIMENTAL APPROACHES TO
# CHEMICAL EVOLUTION

KAMALUDDIN

**Enough experimental evidence now exists to prove that life on earth originated through a series of complex chemical reactions**

DURING the last few decades experimental and theoretical evidences have led us to believe that life on earth must have evolved as a result of several complicated reactions that occurred among the primitive substances present on earth's surface. Step by step the complexity of the reactions increased and more and more complex molecules were formed which ultimately took the shape of what may be designated as a living cell. This idea was first proposed by a Russian scientist A.I. Oparin in 1924 and since then researchers have been trying to find out more about it.

The problem of origin of life is interdisciplinary because to understand it properly, besides an adequate knowledge of biology, knowledge of chemistry, geology and astronomy, etc., is also required. Therefore, in recent years, the study of chemical evolution and origin of life has attracted researchers from different disciplines.

In the beginning of this century, S. Arrhenius, a Swedish chemist, propounded the theory of 'Panspermia', according to which life did not originate on earth but was brought in from outside. This theory was discarded on the basis of the fact that living organism could not have survived the exposure to strong ultraviolet rays during the long course of travel through space. Recently, Fred Hoyle and Vikram Singh at Cambridge University, England, have claimed that origin of life took place in the depths of comet heads which later transferred to the earth when they came closer. From radio astronomical studies, i.e., the study of the electromagnetic impulses emitted by the celestial bodies in the range of radio waves, they were able not only to detect several simple organic molecules of biological relevance but a complex molecule which they suspect to be cellulose in the interstellar clouds.

Another theory known as 'Directed panspermia' has been suggested by Francis H. C. Crick and Leslie E. Orgel of U.S.A. They propose that the earth, and presumably other sterile planets, might have been deliberately seeded by intelligent beings living somewhere in the solar system whose evolution predated our own. One point which seems very strong in the support of 'Panspermia' theory is the fact that molybdenum, which is quite scarce in the earth's crust, is very essential for living systems. Although one can neither prove nor disprove the theory of Panspermia, it is certain that if life did not originate on earth, it must have evolved at a place with conditions not much different from those present on the primitive earth. Thus, it must have been free from strong ultraviolet light and free from oxygenic atmosphere, since oxygen molecules are dangerous and corrosive to carbonaceous substances.

On the basis of the various radioactive isotope methods of dating, life has been estimated to have been evolved some 3.5 billion years ago on earth while the earth itself was formed some 4.6 billion years ago. This means that it took about 1.1 billion years for life to evolve on earth through a series of chemical reactions which led to the first living organism. The process by which all those chemical reactions ultimately gave rise to life is known as chemical evolution.

Since long, living systems were thought to arise from organic matter which in turn was derived from living organism. This means, organic substances would not have been synthesized before the origin of life on the earth, or in other words, only inorganic substances existed on the earth before the origin of life. This implies that 'The first organism born on the earth must be organism able to grow ingesting exclusively inorganic substances', and that is what we call autotrophic organism. It was a generally accepted concept by the scientists till the beginning of the 20th century. But in 1924 A.I. Oparin, a Russian graduate from the University of Moscow, raised a fundamental contradiction to the above concept. How could the first individual of the autotrophic organism have obtained organic substances for its own construction? And this phenomenon cannot be explained to have occurred just by a chance. Oparin proposed that the origin of life is a step of evolution of materials on the earth. Before the origin of life there existed the abionic synthesis of organic materials. Further abionic organic synthetic activity was more pronounced before the origin of life but faded when the living organisms

---

Dr. Kamaluddin teaches chemistry at University of Roorkee, Roorkee themselves started vigorous synthesis of organic materials on the earth. He also recognised that present autotrophes have morphologically, physiologically and biochemically advanced characters which are a consequence of biological evolution, and hence cannot be regarded as the most primitive one.

The impact of Oparin's work was profound. He was the first to set out a series of hypothetical steps by which life might have emerged and the possible duplication of these steps in the laboratory offered an experimental proof of the origin of life. Chemists could now investigate each stage of Oparin's hypothesis.

Based upon the present day knowledge of biochemistry one can define a living system as one having the ability to carry out energy transfer reactions, substrate metabolism and information transfer ability and all these characteristic functions being mediated through proteins and nucleic acids in the cell. The most fundamental reactions necessary for life could be :

(1) Formation of proteins :—The formation of the peptide bond when the carboxyl function of an amino acid reacts with the amino group of another amino acid, with the production of one molecule of water (Fig. 1).

(2) Nucleic acid synthesis —The end result of a number of reactions :

(i) Nucleoside synthesis through the reaction of a purine or pyrimidine with ribose or deoxyribose to form a nucleoside (Fig. 2).

(ii) Phosphorylation of nucleoside leading to the synthesis of a nucleotide (Fig. 3).

(iii) Polymerisation of nucleotides through formation of ester bonds between the phosphate residue of one nucleotide and hydroxyl group of the pentose residue (Fig. 4).

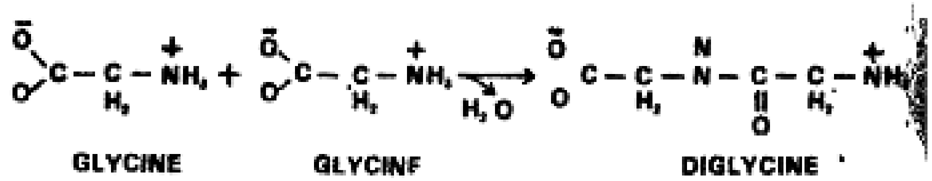

Fig. 1

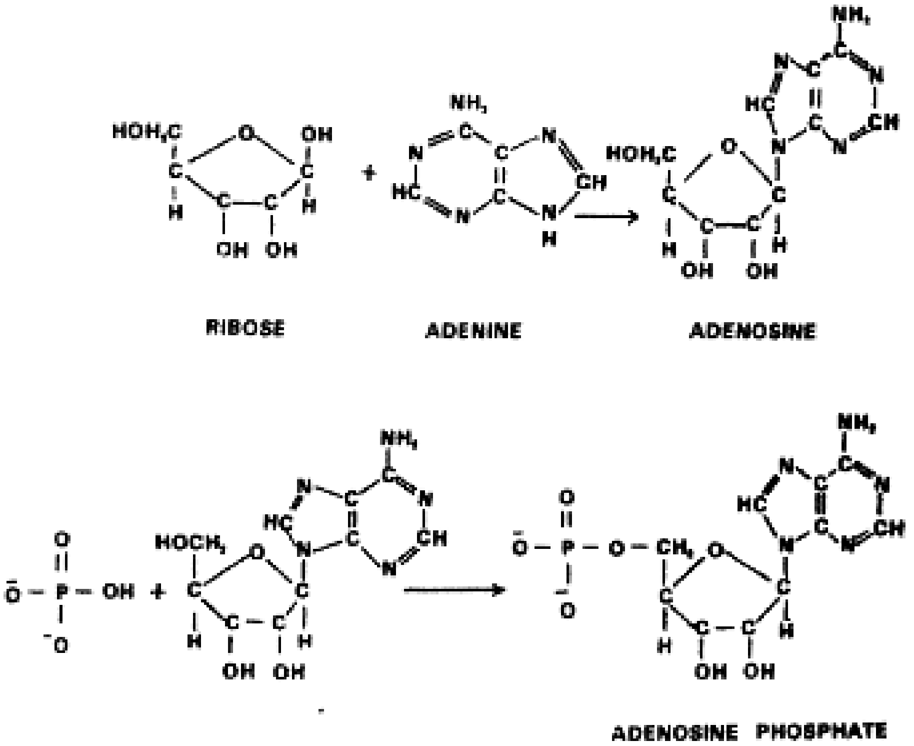

Fig. 2

At present, it is widely believed that the first living organisms had the same composition as the contemporary ones because amino acids, sugars, purines and pyrimidines are major products of reactions carried out by different researchers under prebiotic conditions. Of course they are not the exclusive products but they are the major products. The simple reason that amino acids, sugars and so on were the constituents of the first living organism could be that they were abundant on the primitive earth. A gradual development from simple molecules to the emergence of life occurred successively, probably through the following events:

(1) the synthesis of the small molecules (e.g., amino acids, the monosaccharides, organic bases, etc.);

(2) the condensation of these small molecules into biomacromolecules—especially proteins and nucleic acids;

(3) the organisation of the macromolecules into a system of increasing complexity; and

(4) the emergence of life.

The initial step, the synthesis of the small organic molecules, has been extensively studied. Many of the small molecules necessary for life have been synthesized under presumably prebiotic conditions. First experimental approach to the origin of life on the earth was made by Stanley L. Miller at University of Chicago in 1953. Assuming that primeval atmosphere was highly reducing, Miller chose methane as carbon source and ammonia as nitrogen source and he obtained various amino acids, from a mixture of $CH_4$, $NH_3$ and $H_2$ by electric discharge on a water phase. Following the pioneering work of Miller several amino acids have been synthesized by bubbling methane

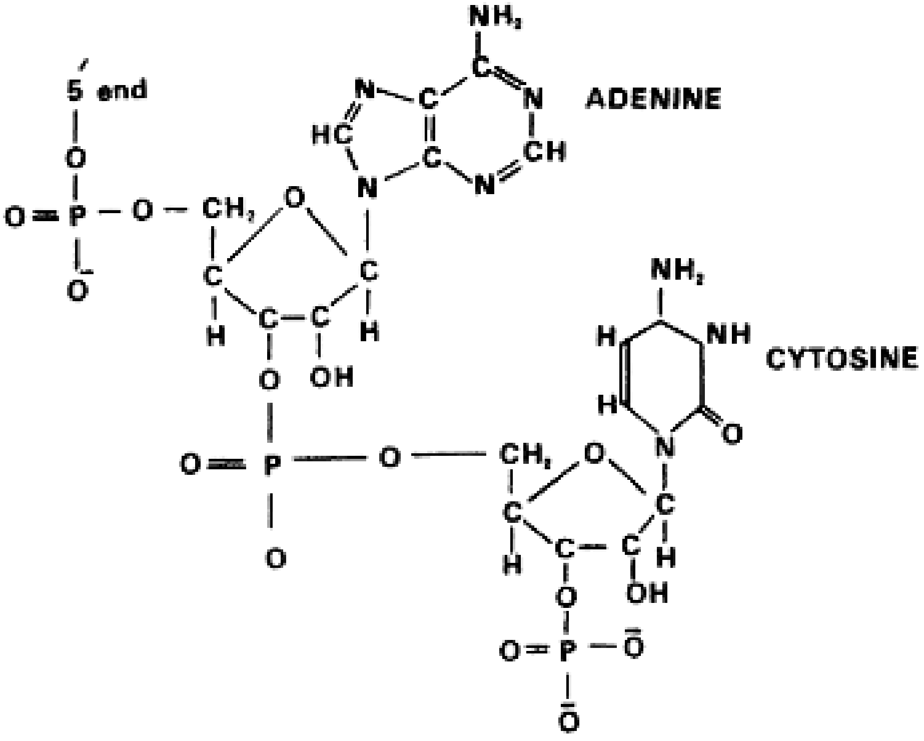

Fig. 3

through aqueous ammonical solution and by passing the mixed gases through solid silica gel, quartz sand in a glass reaction tube heated to 900°C-1100°C by Kaoru Harada and Sidney W. Fox at University of Florida in 1964. Energy from electric discharge was also used by Cyril Ponnamperuma and his coworkers at the University of Maryland for the synthesis of many biologically important species from methane, ammonia and water vapours under reducing atmosphere. Monosaccharides were synthesized from formaldehyde by Gabel and Ponnamperuma in 1967. Purines and pyrimidines were synthesized by plausible prebiotic reactions of alkaline HCN by J. Oró and Kimball in 1962 at the University of Houston, U.S.A., In all such preliminary experiments reducing atmosphere were considered as most probable for chemical evolution. However, strong doubts have been raised for the existence of such a highly reducing atmosphere especially after the Viking mission to Mars. Probably less reducing atmosphere should now be taken into consideration.

In the second step, condensation-polymerization products, prototypes of proteins, nucleic acids, polysaccharides and lipids were produced. Then, through interaction among these macromolecules and by natural selection process the products approached more and more the form of a 'living cell'. It is easy to postulate the hypothesis given above, but we have very little experimental facts to support this conclusion. The study of this stage in chemical evolution, viz., the formation of macromolecules, put the researchers in search of the driving force which made these monomers come together and create complex molecules.

What followed could be this :

Clays present on the seashore first adsorbed the monomers which then detached in activated form and combined together leading to the formation of macromolecules. (The work on this aspect is being actively carried out by the group headed by J. G. Lawless in NASA laboratories at Moffetfield, California. They have synthesized a polypeptide containing a maximum of eight amino acid molecules, using different clays).

Condensation reactions have been carried out with several prebiotic condensing agents (Fig. 4).

The surprising thing is that most of the condensing agents are derived from HCN. J. Oró was first to synthesize adenine from HCN alone. It is now generally believed that HCN

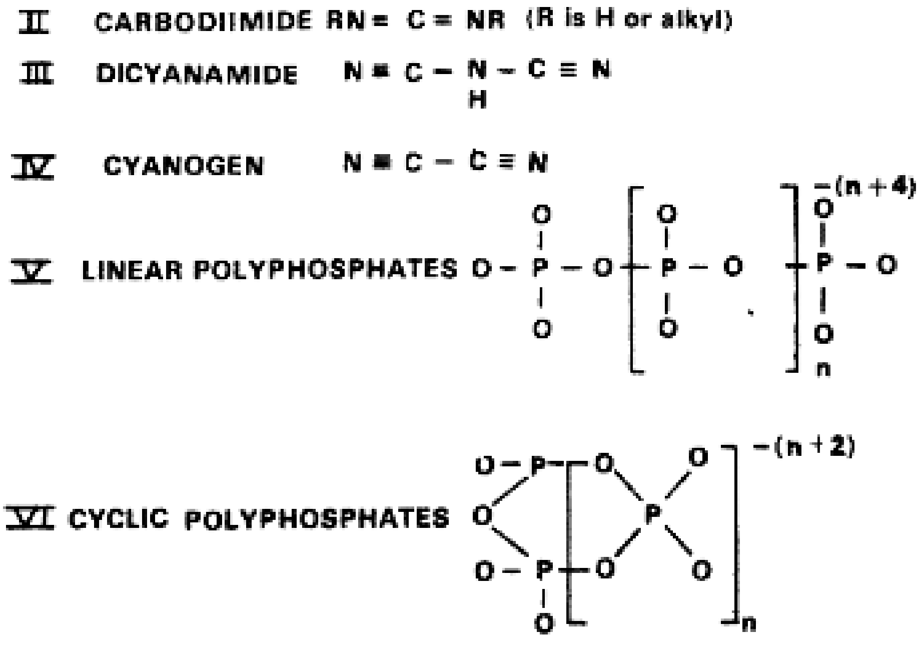
II CARBODIIMIDE RN = C = NR (R is H or alkyl)
III DICYANAMIDE N ≡ C – N – C ≡ N
H
IV CYANOGEN N ≡ C – C ≡ N
V LINEAR POLYPHOSPHATES
–(n + 4)
n
VI CYCLIC POLYPHOSPHATES
–(n + 2)
n

Fig. 4

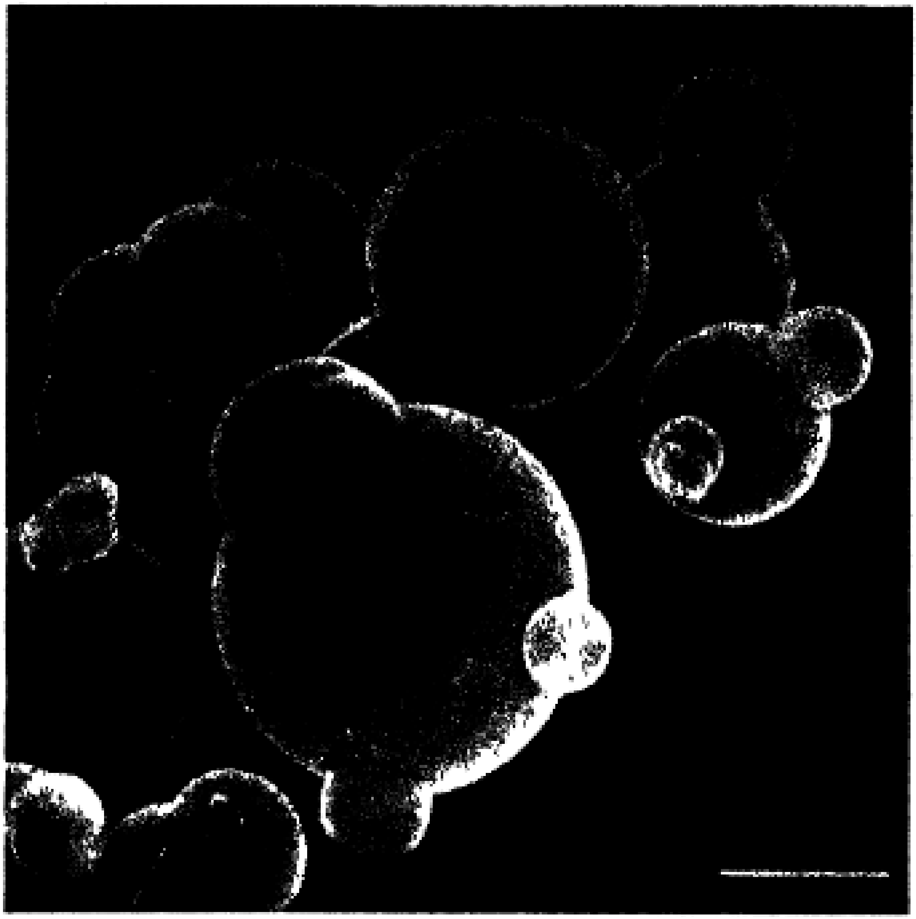

**Fig.5. Photograph of marigranules formed in modified sea medium from glycine and acidic (Glu, Asp), basic (Arg, lys, His); and aromatic (Phe, Try, Tyr) amino acids; scale : A bar represents 1 μm in length** (*Photograph courtesy*: **Dr. H. Yanagawa of Mitsubishi—Kasei Institute of Life Sciences; Tokyo .**

is the precursor of early life. The reason lies in the following facts:

(i) In almost all the simulated experiments carried out so far, cyanide has been confirmed as one of the products;

(ii) Cyanide seems to be the most primitive and basic molecule of biological significance as it is the simplest molecule containing a nitrogen and a carbon atom; and

(iii) The carbon nitrogen triple bond probably provides a lot of energy source for its polymerization or as an active reaction site for other molecules present near around.

After the historic synthesis of adenine from an alkaline solution of HCN, there has been a flurry of activity. Many papers have appeared showing the formation of several amino acids, peptides and organic bases (purines and pyrimidines). Among others J.P. Ferris of Rensselaer Polytechnic Institute of New York has recently shown that in his simulated experiments of the primitive earth, a dilute aqueous solution (0.1M) of HCN by standing in dark at room temperature at pH 9.2 for 0.5 to 1.5 hours, produced a low-molecular weight oligomeric species. The substance released purines, pyrimidines and amino acids on heating in aqueous (pH 8.5) solution at 110°C, and thus demonstrated that all the varied building blocks for life such as purines, pyrimidines, and amino acids could have been formed at the same time and place from the same starting material, HCN. Once these monomers are formed their condensation may successfully be achieved by several dehydrating agents themselves formed from cyanide.

It is now generally accepted by scientists that chemical evolution and origin of life took place in the primeval seas on earth irrespective of the starting materials. The most accepted hypothesis for the conditions under which prebiotic reactions took place is one extended by the Japanese biochemist Fujio Egami in 1974. Egami reported that a good correlation was found between the biological behaviour of minor elements, such as molybdenum, zinc and iron and their concentrations in the present sea water. A hypothesis has been presented that the composition of the present sea water reflects that of the primeval sea water at the time of early evolution. In accordance with the above hypothesis, iron, molybdenum and zinc, are the most abundant transition elements in sea water, and are found to be essential components of the enzymes in microrganisms, including *clostridium*, which is regarded as the most primitive existing organism. These transition elements presumably complexed with the compounds accumulated in the primeval sea in the course of chemical evolution, forming compounds which subsequently evolved to form protoenzymes with a low activity and broad specificity.

Taking into consideration the fact that essential transition metal ions had to contribute to chemical evolution in primeval sea water, and anticipating the concerted catalytic action of clays and metal ions, Egami and his coworkers got a packed organized particle which they called marigranules (Fig. 5). The particles were (0.3-2.5 μm in diameter and were produced from glycine and acidic (Glu, Asp), basic (Arg, Lys, His), and aromatic (Phe, Try, Tyr) amino acids in a modified sea medium containing magnesium sulfate, calcium chloride, dibasic potassium phosphate and six transition elements ($Fe^{3+}$, $Mo^{6+}$, $Zn^{2+}$, $Cu^{2+}$, $Co^{2+}$ and $Mn^{2+}$). The reaction was carried out at 105°C for 8 weeks under nitrogen atmosphere.

The infrared spectrum of the marigranules suggested the presence of peptide bonds showing first amide band at 1680-1610 $cm^{-1}$ and second amide band at 1550 $cm^{-1}$. The marigranules were solubilized by treatment with NaOH solution. The solubilized marigranules consisted of polymers with molecular weights of 1800, 6900, 10000 and 82000 daltons. When solubilized marigranules were digested with enzyme elastase, 34 per cent of total nitrogen was released as primary amino groups. It, therefore, seemed that the marigranules consist of polymers with an elastin-like structures. It is believed that such particles might have been produced in primeval sea before the origin of life. In this way marigranules joined the group of protocell-like structures such as "coacervate droplets" of Oparin and "microspheres" of Sidney W. Fox of University of Florida (U.S.A.).

The coacervate droplets of Oparin were obtained from gum arabic and histone. Oparin regarded it as a simplest model for the flow of materials through living cells as these droplets can incorporate phosphorylase and $\beta$-amylase from the surroundings and can perform the metabolism. It can also incorporate glucose 1-phosphate from the surroundings and excrete metabolic porducts, phosphate and maltose as waste products.

Proteinoid-microsphere described by S. W. Fox and Kauro Harada is regarded as another model of protocell. Proteinoides are amino acid polymers produced by heating a mixture of amino acids. It was thought that such condensation polymerization of amino acids might have occurred during the volcanic activities on the primitive earth. According to Fox and Harada proteinoid-microspheres possessed several enzyme-like biological activities.

Besides the investigations for the production of protocell-like structures, we have to consider various functions characteristic of life and structures which enable the living functions to occur. Briefly speaking, such structures must have a boundary which separates it from the surrounding and it must have the capability of metabolism and self-reproduction. The experimental approaches towards this line are scanty.

It is clear that a wide spectrum of molecules is continuously being synthesized in nature's laboratory (living systems). The amazing part is that all these reactions take place under mild conditions of temperature and pressure. One of the cherished goal of scientists is to mimic nature, or in other words, to carry out the processes which ordinarily require very drastic conditions under conditions prevalent in nature.

There is a misconception that the studies on chemical evolution and origin of life are confined to the production of babies in test tubes. However, this is only a small part of the spectrum. Ilya Prigogine, the Russian-born Belgian scientist and Nobel Prize winner for chemistry in 1977 compares distribution of entropy in non-equilibrium conditions such as in the chemistry of living cells to the betterment of urban planning. According to him both a town and a cell are analogous since they are open systems and their structures are far from equilibrium. Due to low energy processes which are being carried out by living systems their study can have major impact in shedding light on viable processes which can transfer the high energy-intensive synthetic processes to low energy processes. The application of studies on chemical evolution is unlimited and is sure to open up new and useful reaction pathways while saving energy. The science of this study is still in its infancy and its concerted exploration will prove very fruitful.

**Further reading**

1. Lehninger, A. L., *Biochemistry*, 2nd Edition, Worth Publishers, N.Y. (1975).
2. Miller, S. L., and Orgel, L.E., *The Origins of Life on the Earth*, Prentice-Hall, Inc., Englewood Cliffs, New Jersey (1974).
3. Goodman, M., and Moorhouse, F., *Organic Molecules in Action*, Gordon and Breach Science Publishers, N.Y. (1973)
4. Hulshof, J., and Ponnamperuma, C., *Origins of Life*, 7 (1976) 197.

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## FOR HER

*(Continued from page 6[illegible])*

contraction, many women experience it during nursing. Secretion of oxytocin can be stimulated even by higher brain centres. Even the cries of a hungry baby may cause mother to secrete milk. Mental tension on the other hand may inhibit release of oxytocin even when the baby is suckling. It is no wonder that psychological factors play an important role in the nursing of an infant.

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# SCIENCE SPECTRUM

## Did earth ever have a ring ?

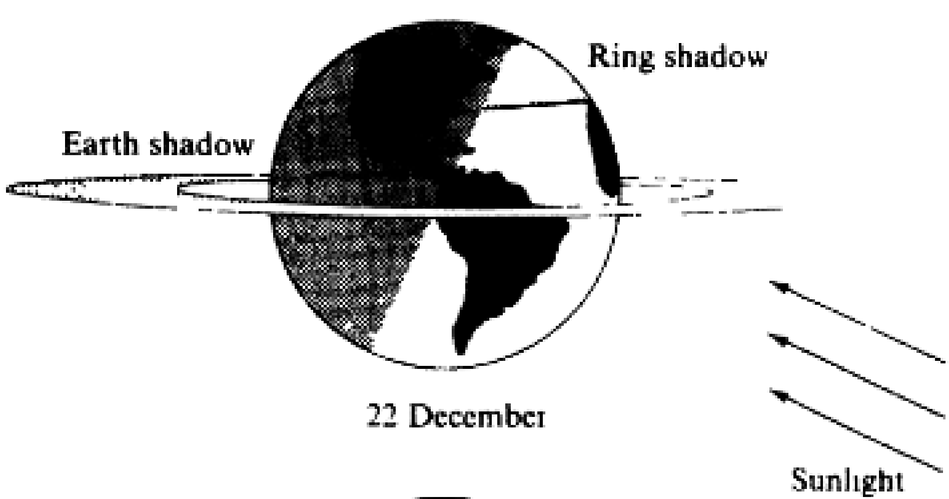
IN view of the recent discoveries of rings around Jupiter and Uranus (notwithstanding the well-known Saturn ring) a question that puzzles scientists and astronomers is : Did earth ever have a ring? As if in an answer to the question, a recent issue of *Nature* (285, 5763) contains a paper that says: "Yes, earth had a ring, a temporary one, obviously, when the ancestors of man had just evolved on the face of earth." According to the author of the paper, John A. O'Keefe, of Goddard Space Flight Center, U.S.A., the earth had a ring about 34 million years ago, in the Eocene epoch of the Cenozoic Era. His theory explains away in a shrewd manner some of the inconsistencies seen in the climate over the earth in that period of its evolution.

Botanical studies claim that about 34 million years ago, there appeared a sudden change in the relative abundance of forest plants. The change is attributed to the peculiar way the climate behaved in the period. It has been ascertained that during this period the temperature in the winters went down by about 20 degrees, while it hardly changed in the summers. An old theory claims that this peculiar climate phenomenon was due to a change in the axis of rotation of earth by as much as 25 to 30 degrees. However, the theory has some apparent flaws.

The orbit of earth around the sun is not only ecliptical but is also inclined at an angle of 23½ degrees to the equator of the sun. The former makes the sun vary its distance from earth over the year. The latter makes the sun trace in the sky of earth a path, called ecliptic, which is inclined to the equator of earth at an angle of 23½ degrees. The sun thus changes its position in the sky of earth over the year. In other words, the direction of incident sunlight changes over the year (See Fig. 1). These two factors, among others, affect the heat balance of earth and thus the seasons. Now if the axis of rotation of earth itself changes, as it has from time to time, it is apparent that the seasons would be affected. However, climatic changes due to shifting of earth's axis of rotation have occurred in the past but slowly and gradually on a time-scale of billions of years and in not so small a time-scale of a few million years as is required in the above case. Therefore, O'Keefe's theory of formation of a temporary ring around the earth at that time sounds a highly attractive alternative.

Wherever the shadow of the ring would fall on the surface of earth, the sunlight would get reduced by 75 per cent causing a fall of 20 degrees in temperature. Apparently, during winters, when the sunlight would strike the earth at a small angle (See Fig. 1), the ring would cause a large shadow on the tropical areas of earth, bringing down the temperature. During summers, when the sun would be right over the equator, the sunlight falling normally on the ring, the latter would hardly produce a shadow. The temperature would then hardly change, as is desired in the botanical evidences. The question that now arises is : how did the ring come into being ?

In recent years, it has been increasingly felt by astrophysicists that "tektites" have an extraterrestrial origin. Tektites are homogenous, non-porous, water-free, glass-like pieces, several decimeters in size, whose chemical composition is unlike any rock or soil on the earth. Huge fields of tektites have been found in many parts of the world. The point of interest here is that one of the largest fields of tektites, known as North American field, which extends from the Caribbean to the Central Pacific via the Indian Ocean, was formed about 34 million years ago at the very time the aforementioned climatic change occurred. The time of formation of this tektite field is deduced from the sudden extinction of several species of Radiolaria (minute marine creatures) which occurred at that time. It would not be out of place to mention here that a few scientists have also claimed that this cloud of tektites coming from space brought about the required climatic change by screening the sunlight, which the latest calculations, however, do not support.



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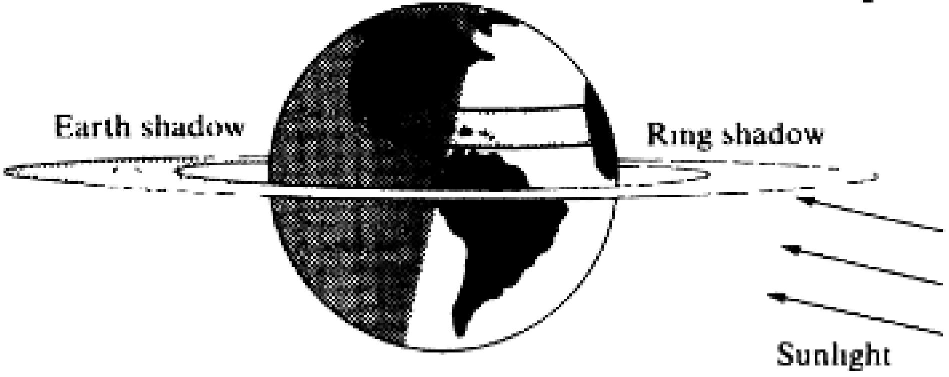

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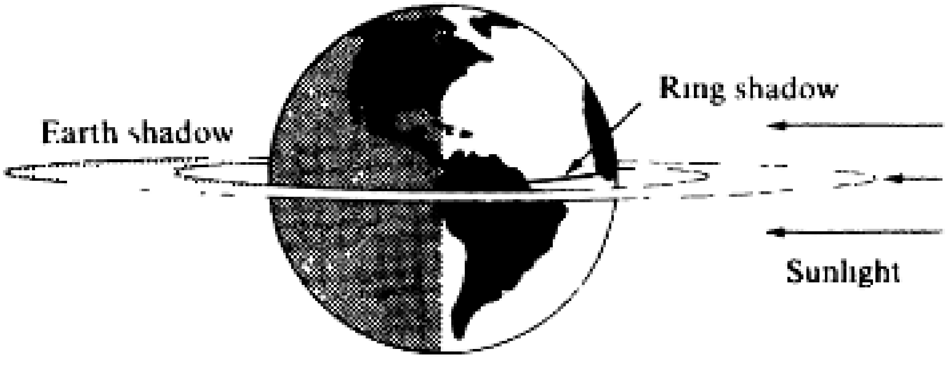

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Fig. 1

According to O'Keefe, the cloud of tektites coming from space got trapped in an orbit of earth. The cloud, however, remained high above the terrestrial atmosphere so as not to settle down to the surface of earth immediately. It also did not stay beyond the Roche limit to become unstable and disperse. The cloud remained at an altitude ranging from 1.5 to 2.5 times the radius of earth. Weighing $25 \times 10^9$ tons and spread over an area of $1.6 \times 10^8$ km$^2$, the cloud was densest at the layers nearest to the earth. Within half a day it collapsed in the equitorial plane of earth and within a year the formation of the ring was complete. O' Keefe' estimates that the life of the ring was a few million years. The forces that tried to pull it in a direction away from earth and finally disintegrated it were atmospheric drag, tidal effects, and collisions among the tektites, to name a few.

Whether the terrestrial ring would bear the scrutiny of further research, howsoever convincing its presence looks now, cannot be said at present. It is, however, an interesting example of how certain inexplicable aeons-old evidences are borne out by an idea in circulation, trying to surface somewhere, somehow.

DILIP M. SALWI

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# Boron hydrides

THE Nobel Prize in chemistry for 1979 was awarded jointly to Prof. Herbert C. Brown of Purdue University, U.S.A. and Prof. G. Wittig of West Germany for their pioneering work in organic syntheses. Prof. Brown's work includes many areas of chemistry, but it is his research on boron hydrides and organo boranes that has brought revolutionary changes in the field. His reagents, which he developed to reduce a specific functional group at a specific site in a particular solvent, are unique. The selectivity in reducing a particular group in a multifunctional system by these reagents are of immense help to a synthetic organic chemist dealing with complex molecules.

Boranes are one of the most important classes of electron-deficient compounds. In these molecules, there are more adjacent pairs of atoms (close enough to be regarded as bonded) than electrons required to have an electron pair bond for each pair of atoms. Long before the structure of diborane was known, the compound boranecarbonyl ($BH_3CHO$) had been synthesised which, it was

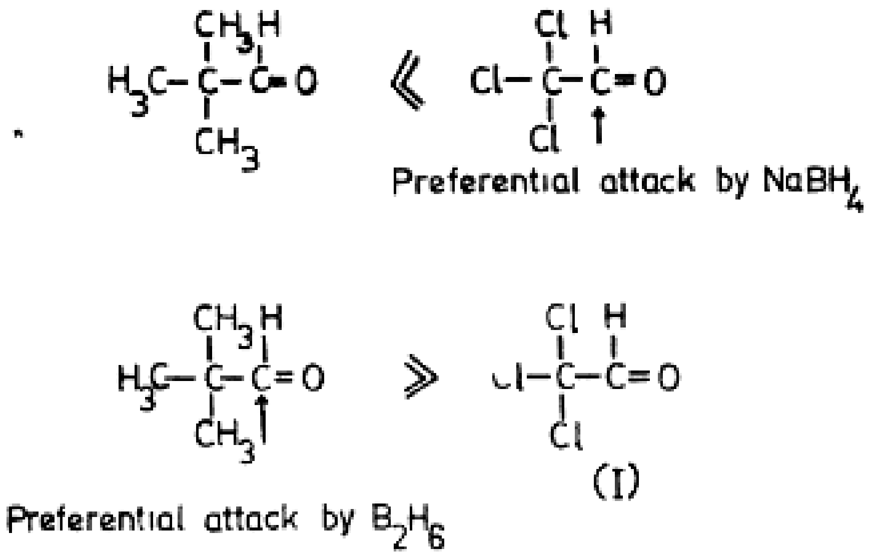

Fig. 1

thought, might exhibit the characteristics of an aldehyde. In 1939, Brown's first paper on the subject established that the simple aldehydes and ketones (in the absence of solvents) reacted rapidly with diborane at 0°C (even at −78°C). This was at a time when organic chemists had no satisfactory method for reducing the carbonyl group of aldehydes and ketones under mild conditions. Brown's use of boron hydrides showed the way.

The first and foremost development in the field were the synthesis of alkali metal hydrides—sodium borohydride ($NaBH_4$) in 1942 and lithium aluminium hydride ($LiAlH_4$) in 1945. These two complex molecules have today become important tools in the hands of the chemist for reducing various organic functional groups such as carboxylic acids, acid esters, acid chlorides, aldehydes, ketones, epoxides, nitriles, olefins, nitro compounds, etc. Sodium borohydride is the mildest of these reducing agents; it reduces aldehydes and ketones rapidly at 25°C, but is essentially inert to other functional groups. It cannot reduce carboxylic acid, acid salt, tertiary amide, nitrile, nitro and olefin groups. Lithium aluminium hydride, on the other hand, is an exceptionally, powerful reducing agent capable of reducing almost all the organic functional groups rapidly. (Excepting its reaction with olefins, it reduces all the functional groups mentioned above). With this broad spectrum of activity in view, the synthetic organic chemists today rarely use the conventional techniques such as the Meerwein-Pondorf-Verley reaction (aldehydes and ketones), the Bouveault-Blanc procedure (esters) or catalytic hydrogenation (nitriles). The two complex hydrides provide a simple and convenient route for the reduction of such functional groups and therefore find wide use in laboratory syntheses.

The problem of selective reduction of a multifunctional molecule is not, however, overcome by these two compounds as $LiAlH_4$ is an exceedingly powerful reducing agent, capable of reducing practically all organic functional groups. On the other hand, $NaBH_4$ is a remarkably mild reducing agent, reducing only aldehydes, ketones and acid chlorides. Consequently there was a need to develop means of controlling the reducing power of these reagents either by decreasing that of $L_4AlH$ or by increasing that of NaBH.

Reductions involving complex borohydrides as well as their modified reagents appear to involve transfer of the hydride moiety from the complex anion to an electron deficient center of the functional group. Consequently, these are called nucleophilic reducing agents (Fig. 1). Diborane is a strong Lewis acid (electron deficient molecule). The reactions involving diborane are expected to involve a preferable electrophilic attack at the centers of highest electron density (Fig. 1). The reaction of diborane with the carbonyl group involves a complexation followed by hydride transfer (Fig. 2). Hence substituents which enhance electron deficiency at the reaction site increase the rate of hydride transfer and thus $NaBH_4$ preferably attacks the carbonyl of chloral (I), whereas diborane is inert to this system. The development of acidic reducing agents such as borane and alane which exhibit entirely different relative reactivities towards functional groups is noteworthy in finding out a

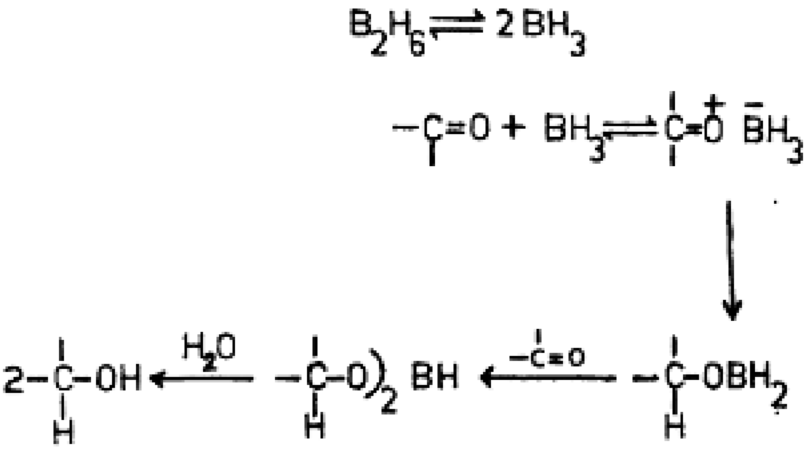

Fig. 2

solution in the search for a selective reductant.

Diborane is a gas (b.p. $-92.5$°C) highly reactive to air and moisture. It dissolves in tetrahydrofuran (THF) in which it exists as the borane THF addition compound. It reduces almost all functional groups including olefins to give organoboranes. Because of its high reactivity with carboxylic acids (inert to many reducing agents) and acid amides, it finds its use extensively in the organic syntheses.

Diborane is no more a chemical rarity and an organic chemist has a multiple choice of specific hydride reagents for specific synthetic transformation. For example, it is possible to selectively reduce an acid chloride in presence of an ester grouping with $NaBH_4$; an ester should be selectively reducible in the presence of an acid chloride by borane-THF. However, the reactivity of different functional groups can greatly be altered by the structures containing them. At present there are numerous reagents, methods and applications based on such hydrides for selective reductions in organic chemistry.

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# The meaning of the maximum permissible dose

THE extensive use of atomic energy in various branches of the national economy, technology, science, biology and medicine has made the study of radiation injuries an urgent problem. Physicians, nurses, technologists and others who work daily near sources of ionizing radiation rightfully wonder if they or their potential offspring will be adversely affected by their occupational exposure to radiation. The critical question is, therefore, "what is the minimum dose which could be considered safe"? There is no radiation dose known as "safe" or harmless. Therefore, the National Council on Radiation Protection and Measurements (NCRP) and the International Commission on Radiological Protection (ICRP) have developed recommendations for permissible dose levels for the population. The levels are set to keep radiation exposure of the individual well below a level at which adverse effects are likely to be observed during his life time. Another objective is to minimize the incidence of genetic effects. The current "standard" or guide for the occupationally exposed is the maximum permissible dose (MPD) or the radiation protection guide. This gives specific upper levels of permitted occupational exposure

## The meaning of MPD

The MPD levels are based on long experience of exposure of man to levels of ionizing radiation which have not demonstrated any harmful effects. As the International Commission on Radiation Protection (ICRP) has said :

The permissible dose for an individual is that dose accumulated over a long period of time or resulting from a single exposure, which in the light of present knowledge, carries with it a negligible probability of severe somatic or genetic injuries; furthermore, it is such a dose that any effects that ensue are limited to a minor nature that would not be considered unacceptable by the exposed individual and by competent medical authorities.

Any severe somatic injuries (such as leukemia) that might result from exposure of individuals to the permissible dose would be limited to an exceedingly small fraction of the exposed group; effects such as shortening of life span, which might be expected to occur more frequently, would be very slight and would likely be hidden by a normal biological variation. The permissible dose can therefore be expected to produce effects that could be detectable only by statistical methods applied to large groups

## History

The evolution of the MPD is summarized in Table 1. Prior to 1928 there was no accepted unit for expressing radiation dose, but by the early 1930's the Roentgen, a unit of exposure to X-rays and gamma rays, was established In 1934, MPD of 0.2 R/day was recommended by the ICRP, whereas the National Committee on Radiation Protection (NCRP) in the United States recommended a level of 0.1 R/day to correct for dose measurements made in air instead of on the skin.

Because of the knowledge obtained and the discoveries of new types of radiation the ICRP reduced the level

**Table 1. MPD values for occupational exposure as recommended by ICRP**

| *Group and Dates* | *MPD level rems/year* |
|---|---|
| Prior to 1934 | 100 |
| ICRP (1934-1950) | 60 |
| NCRP (1935-1948) | 30 |
| ICRP (1950-1956) | 15 |
| ICRP (1956-1976) | 5 |
| ICRP (1977- ) | 5 |

from 0.1 R/day to 0.3 R/week in 1950. However, at about that time the genetic aspects of radiation exposure came under the knowledge of many radiologists. Because of these studies, in 1956 the ICRP recommended a further reduction. The result is the present general MPD level of 5 rems/year (0.1 rem/week) and applies to workers above an age of 18.

The MPD values for various categories of human populations are mentioned in the *Hand Book of the National Bureau of Standards* and the recommendations of the ICRP and NCRP.

### MPD for radiation workers

For persons whose occupations require exposure to radiation or are engaged in the field of radiation, the MPD are :

| | |
|---|---|
| Gonads, whole body bone marrow | 5 rems/year |
| Skin, thyroid and bones . | 30 rems/year |
| Hands, forearms, feet and ankles . | 75 rems/year |
| All other organs . | 15 rems/year |

### MPD for public

The MPD values for members of the public are one-tenth of the MPD for radiation workers :

| | |
|---|---|
| Gonads, whole body and bone marrow . . | 0.5 rems/year |
| Skin, thyroid and bones . . | 3.0 rems/year |
| Hands, forearms, feet and ankles . | 7.5 rems/year |
| All other organs . | 1.5 rems/year |

The MPD values exclude the contributions from medical and natural background. The dose limit for the thyroid of children under 16 years of age is 1.5 rems/year. The annual dose of equivalent limit for members of the public for uniform irradiation of the whole body is 0.5 rems (500 m rems) year.

### MPD for population

The average dose to an entire population is influenced not only by the radiation dose to the individual members of the population, but also by the total number of persons exposed in the population. The population MPD is 0.7 rems /year (5 rems in 30 years). This excludes the background and medical exposures. A recent report indicates that there are two types of population : one is susceptible group and the other is non-susceptible group. The former group is 10 times more sensitive than the latter group, therefore, the same MPD value cannot be applied to all groups of human population.

### Is MPD safe ?

Almost all radiobiologists agree that there is no threshold dose for radiation-induced damage. Therefore, any unnecessary exposure must be avoided at all costs. Frequently, it has been suggested that since there are large variations of natural background radiation, this source of exposure to which man has always been subjected might be used as a suitable, reference standard in setting acceptable levels of exposure to man-made sources of ionizing radiation. The average background dose received by man might serve as a useful guide in setting radiation protection standards, but it is far from being a satisfactory measurement.

There has been a great deal of controversy on the question of whether the present MPD levels are satisfactory and whether they should be continued. In response to federal request, the National Academy of Sciences—National Research Council Advisory Committee on the Biological Effects of Ionizing Radiation (BEIR Committee) undertook exhaustive, critical review of the scientific literature and of additional, unpublished information in its field.

There is no dose of radiation which can be considered "safe" or "harmless". Therefore, continuous efforts must be made to minimize the radiation exposure of the individual from various sources. Before determining any amount of radiation, we must show that benefits derived from such exposure far exceed the possible harm. The nuclear industry will expand rapidly in the future. Therefore, all efforts should be made to minimize the exposure of the individual or population. The extent to which these efforts are successful may well affect the whole future of nuclear energy. The three elements of wisdom, common sense and good judgement are essential if radiation for mankind is to be adequately explored.

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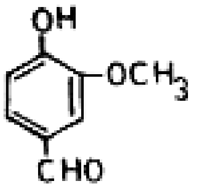
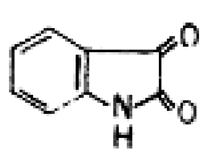
# Chloral and its hydrates

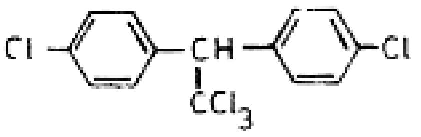
PROFESSOR J. Liebig was the first man to discover and name the compound chloral (Trichlero acetaldehyde, $CCl_3CHO$) in 1832. He obtained chloral by passing chlorine through absolute ethanol. This method is quite common even today. The best results are obtained by chlorinating ethanol directly with chlorine. Many intermediates and byproducts can be converted to chloral, a yield upto 80%-90% being obtainable in the presence of traces of water. Despite much knowledge already attained in the chemistry of chloral, new horizons are yet being opened in this realm.

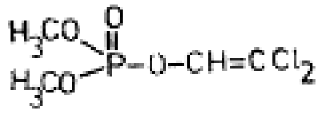
Chloral, as a monomer, is not stable. The high reactivity of the chloral carbonyl group as a consequence of strongly negative inductive effect of the trichloromethyl substituent accounts for low stability of monomeric chloral. Chloral is kept with difficulty because of its capacity to homo- and copolymerize with other monomers (usually in presence of ionic initiators). To stabilize chloral, one uses formamide or dimethylformamide (0.2%-1%). The presence of two functional groups—carbonyl and trichloromethyl—in the chloral molecule and their mutual activating influence extend the synthetic capabilities of chloral as a compound of dual reactivity. It can be transformed into dichlorovinyl and formyl derivatives. Well-known are such key syntheses based on chloral as dichloroacetic acid and its derivatives, vanillin, isatin, DDT, phosphorganic pesticides like Dichlorvos, etc.

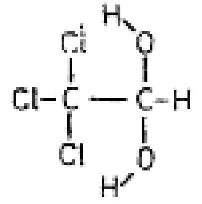
Since chloral carbonyl is highly reactive towards the nucleophiles, chloral results in a stable hydrate ($CCl_3CHO.H_2O$), rather easily, in presence of water. Decomposition of chloral hydrate to chloral is achieved only by distillation over concentrated sulphuric acid or by azeotropic dehydration in toluene or benzene. The stability of chloral hydrate is due to the presence of two hydrogen bonds in the molecule.


Vanillin


Isatin


DDT


Dichlorvos


Chloral hydrate

$Cl_3CCH_2OPO(OH)_2$

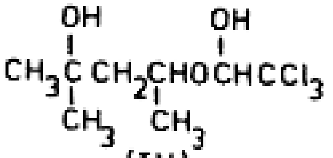
(I)

$Cl_3CCH(OH)_2(CH_3)_3\overset{+}{N}CH_2C\bar{O}_2$

(II)

$C(CH_2OCHOHCCl_3)_4$

(III)



$$CH_3\overset{OH}{\underset{CH_3}{C}}CH_2\underset{CH_3}{C}HO\overset{OH}{C}HCCl_3$$

(IV)

$CH_3CONHCH_2CONH_2\cdot CCl_3CH(OH)_2$

(V)

## Applications

One of the oldest organic sedative and hypnotic agents is chloral hydrate $Cl_3C\ CH\ (OH)_2$. Its introduction into clinical use was based on the false assumption that chloral hydrate would be converted metabolically into chloroform. The hypnotic properties of halogenated alcohols have been well established and it is believed that the active metabolite of chloral hydrate is trichloroethanol. However, the rapid onset of sedation and hypnosis may be due to chloral hydrate itself and the prolonged duration of action may be due to trichloroethanol.

Although chloral hydrate is a safe and reliable hypnotic, its undesirable taste, strong odour and irritation of the gastrointestinal tract have diminished its general use. However, capsules containing chloral hydrate are used widely. But there has been a resurgence of interest in derivatives of chloral hydrate in recent years. These derivatives undergo a hydrolytic cleavage to produce either choloral hydrate or trichloroethanol. Some of them are Trichloros (I), Chloral betaine or Beta-Chlor (II), Pentaerythritol Chloral (III), Cyclohexadol (IV) and Acetyl glycinamide chloral hydrate (V).

Besides its various applications in pharmacology as a hypnotic, sedative and sleeping drug, chloral hydrate finds its use in industry as well. It activates bleaching of cotton and textile. It is used in the electroprecipitation of nickel, for fungicidal wood protection, for detection of a series of glucosides and zinc in insulin and for the isolation of water-soluble starch and amylase from potato starch. It is also an inhibitor of steel and copper corrosion in perchloric acid solutions.

High catalytic activity of chloral is recorded in the polymerization of alkenes and other vinyl isomers, in the preparation of urea-formaldehyde plastics and in some dehydration reactions (particularly in the condensation of amines and ketones). Nowadays chloral is used widely as a monomer for copolymerization because all its polymers have high thermal stability and are fire-resistant. Chloral acetals with dodecylmercaptan are recommended for use in butadiene-styrene rubber production.

Still more common is the use of chloral transformation products. Chloral hemiacetals with polyols are used in preparation of synthetic fibers and ion exchange resins and they have a sedative action. Reaction products between chloral and benzidine or p-phenylene diamine and also copolymers with several oxetanes are good adhesive additions to resins and abrasives.

Chloral itself has a little insecticidal and herbicidal activity; 'meta chloral' is, however, a good herbicide. High herbicidal properties have been exhibited by chloral adducts with amides and nitroparaffins, etc. The known pesticides Triphan, Methoxychor, Methiochlor are also chloralderivatives. An adduct of chloral with nitromethane was patented as a systemic fungicide. Insecticides with strong activity have been obtained from phosphorganic derivatives (e.g., Dichlorovos, o-o-dimethyl-2, 2-dichlorovinyl phosphate) of chloral including both trichloromethyl and dichlorovinyl groups.

Chloral complexes including Fe are used for dyeing chromosomes.

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# Biomagnification of pollutants

POLLUTION is the catchword of the day particularly in the developed countries of the world, and the developing nations are slowly coming to realise the gravity of the problem. We tend to overlook the potential danger of many pollutants since they "disappear" on reaching the atmosphere to infinitesimal levels by ordinary standards. Moreover, some pollutants are degraded, primarily by the activity of microorganisms. However, these are no guarantees for safety. There are some organisms which can, in fact, accumulate pollutants in their tissues and such a phenomenon is known as bioaccumulation.

In the biosphere, the photosynthetic green plants, algae and sea weeds are primary producers of organic matter. They are able to synthesise their cell material by using energy from sunlight and carbon from carbon dioxide. All other organisms are dependent upon these primary producers. For example, herbivores are directly dependent on these plants and are called primary consumers. Carnivores living on these herbivores are secondary consumers and the carnivores feeding on smaller carnivores constitute the tertiary consumers (Fig. 1). This series is called food chain. Each link of the series constitutes a trophic level. Ecologists estimate that such a food chain allows transmission of roughly 10% of the energy entering one level to the next level above it. The simplest version of a system of this kind takes the form of a pyramid. Each successively higher population receives about 1/10 of the energy received at the level below it. Of the energy a population of organisms receives as food, usually less than 50% goes for construction of new tissues. The rest is spent on respiration. This circumstance acts as a concentrating mechanism : a substance not involved in respiration and not excreted efficiently may be concentrated in tissues twofold bringing about bioaccumulation.

A pollutant which is bioaccumulated by a population may be further concentrated when it passes to the next trophic level of the food chain. This process is called biomagnification. Pollutants found at a very low concentration in the environment in the abiotic phase may be concentrated in a stepwise manner as they move up the trophic level, and at higher levels may even upset essential metabolic processes. The most notable example is DDT which became popular after successfully controlling body lice and hence typhus fever during World War II. Now it is so widely distributed all over the earth that it can be detected even in Adelie penguins and skua gulls in the Antarctic. The concentration of DDT in sea is only parts per billion because it has a low solubility in water. But the algae which grow in water absorb this in fats where it is highly soluble. The oar weed *Laminaria* which is at the first trophic level contains 0.001 ppm. A study conducted by Robinson and his coworkers at Shell Research Ltd., Kent, England revealed that sea urchins at the second trophic level contain 0.027 ppm. As shown in Table 1, the concentration reached 1.56 ppm in the liver of shag in the same area. In another study conducted at Long Island, USA, it was

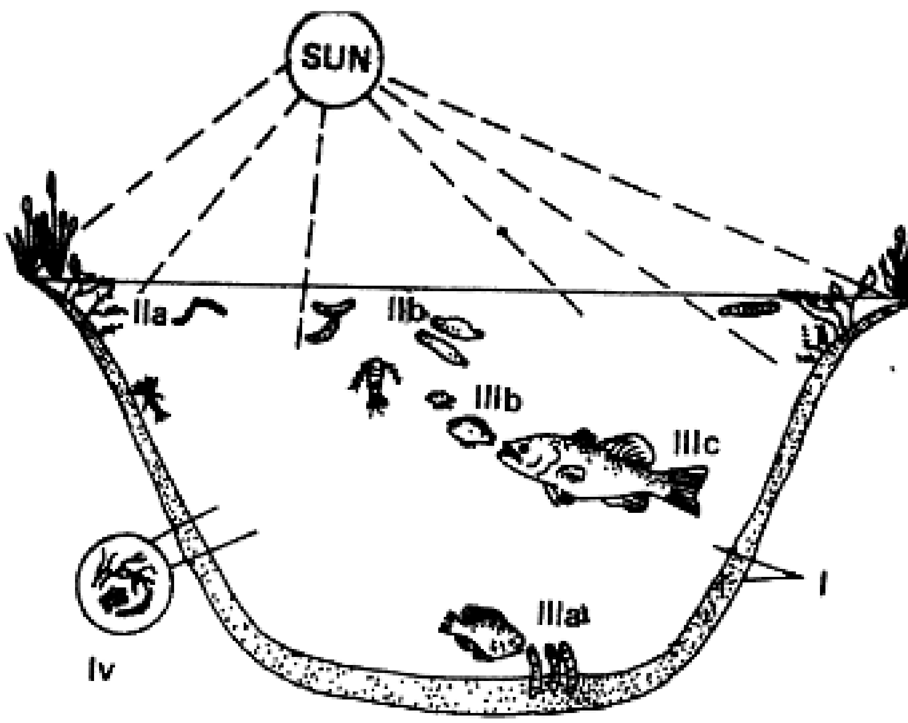

**Fig. 1. The food chain ; I. Abiotic components; II. Producers · IIa-Rooted vegetables; IIb-Phytoplanktons ; III. Consumers · IIIa Primary consumers—herbivores; IIIb-Secondary consumers—carnivores; IIIc-Tertiary consumers—Secondary carnivores; IV. Microbial decomposers**

found that, at the lowest level, the plankton in water contained 0.04 ppm. DDT; minnows contained 1 ppm. and carnivorous scavenging bird 75 ppm in its tissues. It is evident that damage from DDT is particularly serious in higher carnivores. Though mortality is not common, deleterious effects on reproductive system may be observed. Accumulation of pesticides in fish liver fat tissue and in bird eggs is a potential danger for man and wild animals. Indiscriminate use of pesticides not only results in pests developing new strains resistant to chemicals but in accumulating them along the food chain to levels catastrophic for scavenger birds like eagles and hawks. The ecological balance is offset.

Like pesticides, hydrocarbons are also biomagnified. Electron microscopic studies have revealed that microorganisms concentrate hydrocarbons. For example, *Micrococcus cerificans* grown on hexadecane contain inclusion bodies of hexadecane globules. Oysters from contaminated French waters have been shown to contain upto 70 μg/kg 3-4 benzpyrene, the carcinogenic aromatic hydrocarbon.

Polychlorinated biphenyl compounds, commonly called PCB's, are products of plastic industry and are found to increasingly contaminate natural waters. They are strongly recalcitrant, i.e., resistant to biodegradation. They have been found to concentrate in trout as a function of age. For example, one year old trout may contain as little as 0.6 ppm, but by the age of 4, the concentrations reach 3-5 ppm. 12 year old trout may concentrate as much as 26 ppm of PCB. Besides being carcinogenic, these compounds adversely affect the reproductive capacity of organisms.

Mercury enters water bodies as organomercury pesticides or mercury slimicides used in paper industry, mercury paints, etc. Aerobic bacteria convert metallic mercury through mercurous ion into either methyl mercury or dimethyl mercury. These alkyl mercury compounds are hazardous for life because they are water soluble and are easily rapidly absorbed through biological membranes. Moreover, they are not easily degraded or released from the animal body. These compounds are absorbed at the bottom of the food chain by photoplankton and zooplankton and are biomagnified. Jones and coworkers of the University of Dundee, U.K., found that littoral flora and fauna in Tay River estuary contain significant concentrations of mercury. The seaweed *Fucus* and *Laminaria* contained 1.1 μg and 0.7 μg per gram tissue respectively but *Ulva* contained 25 μg. The mollusc *Mytilus* contained 2.1 μg, while the grey seal liver had 224.8 μg.

Other toxic metals like cadmium may also be biomagnified. The ambient concentration in oceans is normally 0.2 ppm, but digestive glands of molluscs contain as much as 10 ppm cadmium. This metal is directly absorbed in the elemental form by phytoplankton and other higher organisms. Lead also accumulates in bacterial and algal cells without harming them. As much as 400 mg lead per gm of bacterial mass may be immobilised from water. Lead is also known to accumulate in submerged plants.

The nuclear power plants pollute environment with long living radionuclides that ultimately find their way to oceans. They may remain in solution or are precipitated chemically and fixed in sediments. The radioactive elements in solution have the potential to accumulate in food chain. For example, $^{54}$Mn concentrates by a factor of 3000 in algae, 2000 in crustacea, $10^4$ in molluscs and 200 in fish. $^{60}$Co on the other hand has a concentration factor of 500 in algae, molluscs and crustacea and 80 in fish. $^{137}$Ce which has a half-life of 30 years emits penetrating gamma rays. Because it behaves chemically like potassium, an essential component of all cells, it becomes widely distributed once it enters the body. Consequently, it is passed along the food chain and the concentration factor is said to be 2-3 for each step. In contrast to $^{137}$Ce no significant uptake of $^{85}$Krypton has been observed.

Biomagnification of pollutants calls for greater attention to environment. Vastness of the earth is no safety against the dangers of pollution.

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# Change over to cheese

THE term 'Cheese' is considered to be derived from a word *Chiz* of Indian origin. But the product itself is not so popular in India though it has much significance in the diet of the people of the advanced countries. In India it has been accepted only by the affluent. Time has come when the masses should be well informed about its merits and demerits.

Milk production in India is gradually increasing due to the genetic improvement of the selected breeds of milch cattle by using imported semen of the exotic breeds and also due to better care and management of the livestock. India now produces milk powder for infants, condensed milk, icecream, butter, ghee, etc., from milk. When our market will be saturated with these products, the dairy industry may start manufacturing cheese for various reasons. Unlike other products, cheese has some added advantages in respect of storage and utility. Making of cheese as a means of preserving the most important constituents of milk in a highly concentrated form is in vogue all over the world. It provides a palatable milk product of high food value which has a longer shelf-life.

There are probably about 18 distinct varieties of cheese having more than 400 names. It is possible, however, to classify cheeses according to two general types, namely, hard and soft, depending upon the moisture content of the product.

**Indian varieties**

Of all the different varieties of cheese, Cheddar cheese occupies the premier position in the world trade. In its ripened form or even after melting and processing, this product has been found quite acceptable. In Indian sub-continent three varieties of soft cheese, viz., Surti cheese, Bandal cheese and Dacca cheese are known. But they have no prominence in Indian market. In India mainly cottage cheese (*Paneer* and *Chhana*.) is prepared in small quantities and consumed fresh. They are consumed as such or used in preparation of different delicacies.

Cheese consists of concentrated constituents of milk, mainly fat, casein (protein) and insoluble salts, together with water in which are present small amounts of soluble salts, lactose and albumin. To retain these constituents in concentrated form milk is coagulated either by means of lactic acid produced by bacteria (*Streptococcus lactis*) or by addition of rennet (a proteolytic enzyme). A portion of water is removed by cooking, stirring and then draining out the whey with or without application of pressure. The cheese may or may not be ripened; if ripened, nature of the process of ripening depends on the particular variety.

Scientists consider cheese as an important food item of the human diet because, (a) it is an economical source of milk protein, (b) it is a rich source of calcium, (c) it is highly digestible, and (d) it is an excellent source of several vitamins.

Since cheese is predigested by bacteria, it can be included in the diet of children and persons who suffer from digestive disorder. Anybody who is a regular consumer of ripened or processed cheese may distinguish the difference between cheese and other proteins, particularly from digestion point of view.

During the process of ripening of cheese, desirable microflora, mainly

**Table 1. Average composition of cheese and milk**

| *Milk/Cheese* | *Moisture* % | *Fat* % | *Protein* % | *Carbohydrate* % | *Ash* % | *Ca* | *P* | *Iron* | *Vitamins* | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | *mg/100 gm* | | $B_1$ | $B_2$ | *Niacin* | *A* *IU/100 gm* |
| Milk | 87 | 3—9 | 2.5—3.5 | 4—5 | 0.7 | 118 | 93 | 0.1 | 0.04 | 0.17 | 0.1 | 160 |
| Chedder cheese | 37 | 32.2 | 25 | 2.1 | 3.7 | 725 | 495 | 1.0 | 0.02 | 0.42 | Trace | 1400 |
| Cottage cheese | 76.5 | 0.5 | 19.5 | 2.0 | 1.5 | 96 | 189 | 0.3 | 0.02 | 0.31 | 0.01 | 120 |
| Dacca and surti cheese | 35 | 35—45 | 20—25 | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. |
| Bandal cheese | 40 | 50—65 | 10—15 | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. | N.A. |

N.A.-Figure not available

*S. lactis*, acts on the constituents of cheese, viz., lactose, protein, fat, etc. As the ripening period increases, complex protein is gradually broken down to simpler forms and thus insoluble protein gradually becomes soluble. Similarly, a portion of fat also becomes degraded to different compounds. The combined effect of different intermediate and final products (compounds) gives rise to the typical flavour and aroma of cheese.

Cheese is manufactured mainly from good quality milk. In recent years emphasis has been laid on production of cheese from pasteurised milk to ensure quality of the finished product, even though pasteurisation has some disadvantages in cheese manufacture. On the other hand, cheese may be manufactured from poor quality milk too. However, in this case strict control of temperature during ripening process is of extreme importance.

To a majority of the Indian population the typical flavour and aroma of well-ripened cheese is objectionable, and unacceptable. Gradually, however, one becomes accustomed to, and, in fact, extremely fond of it.

Since animal rennet (obtained from calf's or lamb's stomach) is used in the manufacture of cheese, most Indians who are vegetarians may have objection to it. However, with the spread of education population of nonvegetarians is increasing fast and it may well be presumed that this inhibition will not persist. Moreover, continuous research work may be conducted to find the feasibility of replacing animal rennet with either microbial or vegetable rennet.

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# Cheating genes

MENDELIAN inheritance is based almost exclusively on a wonderful process called meiosis—an indispensible process which reduces the chromosome number to half, earlier doubled by fertilization, in the process of male and female gamete formation. It also provides shuffling or recombination of the genes to develop entirely new gene combinations to increase variability in the progeny so that it could face successfully the adverse environmental conditions. "The evolutionary advantage of this shuffling is that it enables genes from different individuals to come together and genes that have been together, to separate. By thus scrambling (or shuffling) the genes in every sexual generation, Mendelian inheritance tests all the genes in many combinations. Genes that increase the capacity for survival, fertility and the survival of progeny are retained by the natural selection; less effective genes are lost. Evolution involves continuous testing and retesting of gene combinations and retention of those combinations that increase reproductive success, with the result that the species becomes better adapted." (Crow, J. F., 1979: *Scientific American*, **240** (2), 134).

## The faithful genes

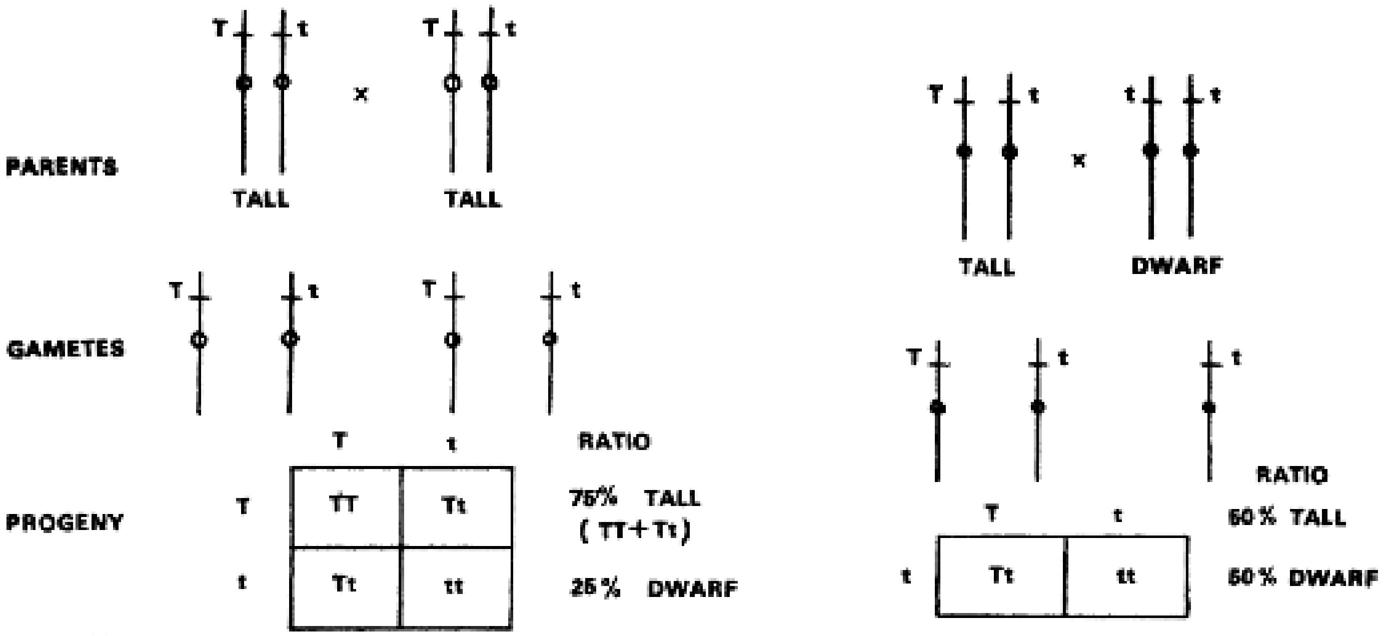
Meiosis, infact, is characterised by the two main processes, i.e., (1) random segregation of the homologous chromosomes derived from both the parents at the time of fertilization, and (2) the random recombination or independent assortment of the genes present on the chromosomes, wherein every free gene is given a free hand to cross-over to develop new gene combinations. The fact that the homologous chromosomes normally segregate freely and that every gene is given equal chance to recombine independently has been proved beyond doubt by recurrence of Mendelian ratios and also by test crosses (Fig. 1). Genes that themselves follow the Mendelian inheritance pattern and also help other genes to do so are called the faithful genes. All genes are not, however, faithful: there are some genes that do not behave faithfully and act selfishly "perpetuating themselves in the population by tricking the reproductive process (meiosis) to work in their own favour (and)... undermine the system (meiosis) generally by reducing its fairness. More directly, such genes usually affect processes other than meiosis and are almost always harmful".

## Cheating genes

The cheating genes that violate the Mendelian principles were discovered about 55 years after the rediscovery of Mendel's Laws by Yuichiro Hiraizumi at the University of Wisconsin, U.S.A. He could not get the expected test cross ratios in all crosses (50:50) in the progeny after crossing a hybrid (or heterozygous) red-eyed male (cnbw/++) with pure (or homozygous) white-eyed (cn bw/cn bw) females. Instead, what he could get in some of the crosses was only red-eyed progeny and no white-eyed ones—a clear cut case of red-eyed genes being selfish and perpetuating themselves only and therefore, distorting the segregation ratio (Fig. 2). They were named segregation distorters (SD).

## Genetics of cheating genes

In *Drosophila*, the SD behaviour is genetically controlled and the two



| | T | t |
|---|---|---|
| T | TT | Tt |
| t | Tt | tt |

75% TALL (TT+Tt)

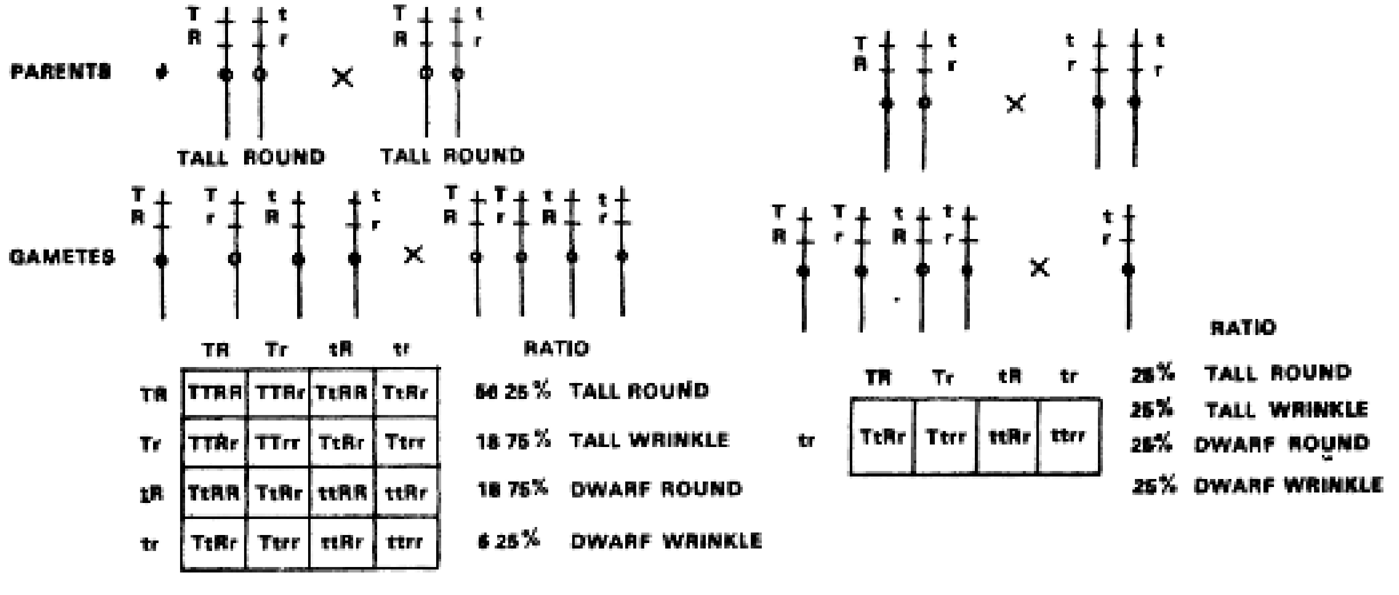
25% DWARF

| | T | t |
|---|---|---|
| t | Tt | tt |

50% TALL

50% DWARF

**Fig. 1.** *(Left) Non-mixing of alleles or principle of segregation*—**When heterozygous tall (Tt) plants are crossed with each other or selfed, the progeny produced is 75% tall and 25% *dwarf* if tallness (T), *dominant over dwarfness* (t); *(Right)* The Test Cross. A test cross is said to be performed when a hetrozygous plant (say Tt) is crossed with a homozygous recessive (say tt) plant which produces progeny of talls and dwarfs in equal proportion**



| | TR | Tr | tR | tr |
|---|---|---|---|---|
| TR | TTRR | TTRr | TtRR | TtRr |
| Tr | TTRr | TTrr | TtRr | Ttrr |
| tR | TtRR | TtRr | ttRR | ttRr |
| tr | TtRr | Ttrr | ttRr | ttrr |

56 25 % TALL ROUND

18 75 % TALL WRINKLE

18 75% DWARF ROUND

6 25% DWARF WRINKLE

| | TR | Tr | tR | tr |
|---|---|---|---|---|
| tr | TtRr | Ttrr | ttRr | ttrr |

25% TALL ROUND

25% TALL WRINKLE

25% DWARF ROUND

25% DWARF WRINKLE

**Fig. 2.** *(Left) Free hand for a free gene or principle of independent assortment.* **Mendelian inheritance gives a free or unlinked gene a free hand to crossover to develop all possible new gene combinations. If Tallness (T) is dominant over dwarfness (t) and Round (R) seed shape is dominant over wrinkled (*r*); *(right) The Test Cross.* The outcome of a test cross involving two genes in the equal proportion of all progenies, i.e., 25% Tall and round; 25% Tall wrinkle, 25% dwarf and round; 25% Dwarf wrinkle**

genes that are responsible for this behaviour are present on either side of the centromere of the chromosome No. II, to which the eye colour genes also belong. All these genes are so arranged that crossing over or recombination between them is not possible and therefore, the complete chromosome is transmitted as such to the progeny.

So far we were concerned with the cheating genes present on one of the non-sex chromosomes, i.e., chromosome No. II of *Drosophila*, but what would happen if such genes were present on one of the two sex chromosomes (XY-male, and XX-female), i.e., on the Y chromosome which determines maleness. Due to the strong tendency of the chromosomes having cheating genes to perpetuate themselves (in this case the Y chromosomes), the progeny would be almost 100% males and none or less number of females. Consequently, all male population will

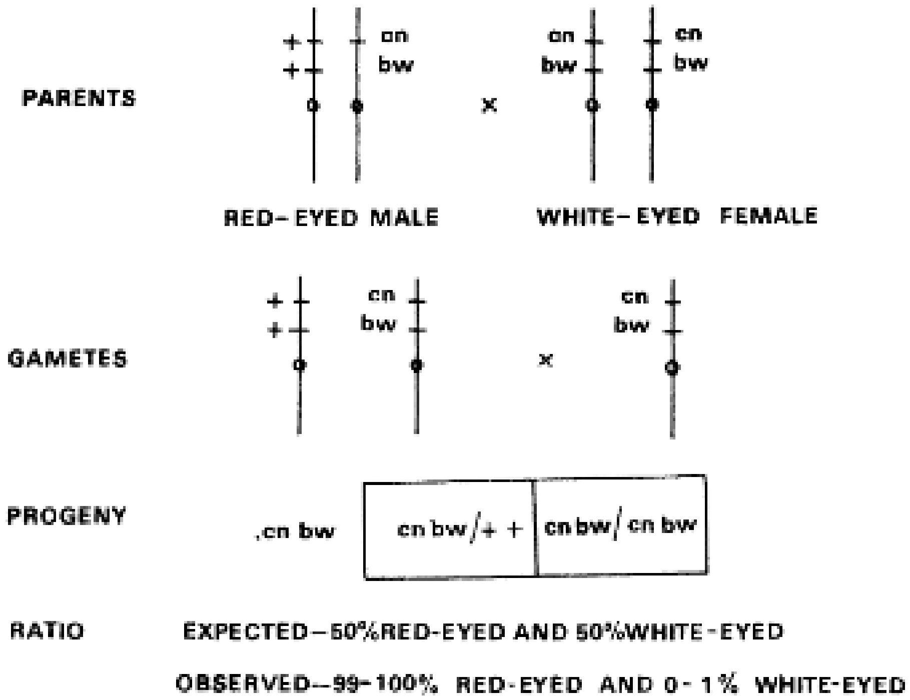


**Fig. 3. The cheating genes.** ***In Drosophila*** **two pigments, cinnaber and brown give normal dark red (+ +) eye colour. When both pigments are missing or are mutated, the eye colour is white (cn bw). Since there is no crossing between the two genes controlling pigment colour in the male** ***Drosophila;*** **the chromosome having these genes is transmitted as such and, therefore, the progeny expected out of a test cross is 50% red eyed and 50% white eyed flies. But in actual practice the progeny produced is almost 100% red eyed, the red eye colour genes being too selfish in separating themselves.**

soon perish because of non-availability of females. Therefore, the presence of the cheating genes is "bad enough on one of the non-sex chromosomes, (and) can be a disaster if it is on the Y-chromosome".

The cheating genes could be made useful to eradicate some diseases if they can be induced on the Y chromosome of the harmful animals like mosquito, mice, etc., which cause hardships to mankind. This however would reduce the variability of the population and hence make the natural selection less effective.

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# Do B-chromosomes affect chiasma frequency and recombination ?

THE term 'B-chromosome' was first of all used by A.E. Longley and L. F. Randolf of the United States (1927-28). These two scientists reported such chromosomes in maize. The term 'accessory' was used by Y. Melander of the United States (1950). B-chromosomes, accessory chromosomes or supernumerary chromosomes are generally used for those chromosomes which are present in a varying number over the normal A chromosome. The use of the term supernumerary looks somewhat ambiguous because it also includes numerical variations like hypoploidy and hyperploidy as reported by Arne Muntzing (1974), Institute of Genetics Univ. of Lund, Sweden. B-chromosome is most commonly used in plants and supernumerary in animals but there is no hard and fast rule in the use of these terms.

B-chromosomes do not have much influence over the phenotype of the individual but some people are of the opinion that B-chromosomes certainly affect recombination and chiasma frequency leading to some change in phenotype Overall, it may be considered as a cytological riddle due to different opinions of people and it deserves further research.

B-chromosomes and supernumerary chromosomes are known in about 700 species of animals and plants reported by H. Rees (1974), Univ. College of Wales, Aberystwyth. Among flowering plants, about 591 species belonging to 219 genera are known to possess these chromosomes. It has been reported by M. J D White (1973), Australian National University, Australia, that various orders of insects possess them. So far as the plant kingdom is concerned, B-chromosomes have been reported in *Poa*, *Rye*, *Sorghum*, *Xanthium texanum*, *Hepplopapus gracilis*, etc. Recently they have been reported in seven species of *Crotalaria* by P. K. Gupta (1975), Department of Botany, Meerut University, Meerut, in *Trigonella foenum graecum* by S. S. Raghuvanshi *et al.* (1978), Department of Botany, Lucknow University, Lucknow, in *Trichosanthese anguina* by S. R. Sen and K. B. Dutta (1973), Department of Botany, Calcutta University and in *Cucumis* species by A. K. Singh and K. S. Yadava (1978), Department of Botany, University of Jodhpur, Jodhpur.

B-chromosomes differ from ordinary chromosomes in the following respects :

(a) Accessory chromosomes are subinert and have less genetic effect;

(b) They occur at variable frequencies and are not stable but mealybug *Pseudococcus obscurus* is an exception where they seem to be stable *mitotically* in the germ line of both the sexes;

(c) Number of B-chromosomes is usually less than A chromosomes. Exceptions are *Zea mays*, *Centuria scabiosa* and *Tradescantia paludosa* where number of B-chromosomes is higher than the number of A-chromosomes, e.g., in *Z. mays*, A-20, B-34, in *C. scabiosa*, A-20, B-22 or sometimes equal to the number of A-chromosomes, as in *Tradescantia paludosa* A-12, B-12;

(d) In certain lilies, the B-chromosomes are increased in number in the embryo sac but not in the pollen; and

(e) B-chromosomes are generally smaller than the ordinary chromosomes but there are exceptions, e.g., in grasshopper *Myrmeleotettix maculatus*, B-chromosomes are larger than A-chromosomes.

Like A-chromosomes, acrocentric and metacentric terms are conveniently used in case of B-chromosomes. Particularly in animals and insects, supernumerary term is most commonly used. Both acrocentric and metacentric types of supernumeraries are found in grasshoppers *Trimerotropus sparsa* and *Circotettix thalassinus*.

It has been observed that in some individuals they are present at somatic level, but are eliminated at meiotic level. In others, they are constantly present in meiotic and mitotic stages. In certain plants like *Agrostis*, *Dactylis*, *Festuca* and *Secale*, their number remains constant in all tissues.

Many researchers have claimed the direct effect of B-chromosomes on recombination and chiasma frequency. Arne Muntzing (1974) reported the effect of B-chromosomes on recombination patterns in rye. G. A. Dover, Deptt. of Genetics, Univ. of Cambridge, Cambridge and R. Riley (1972) of Plant Breeding Institute, Cambridge, England, working on wheat, G. M. Evans and A. J. Macfield (1974) of England working on *Lolium* have observed that B-chromosomes modify chromosome pairing in hybrids between closely related species. R. Neil Johnes and H Rees of Univ. College of Wales (1967) reported variation in crossing over in relation to the number of B-chromosomes. F. M. Cameron and H. Rees (1967) of Univ. College of Wales, Aberystwyth working on *Lolium perenne* told that chiasma frequency was highest in plants lacking B and decreased in plants having one or two B-chromosomes. So recombination is decreased in this case. B. John and G. M. Hewitt of Institute of Advanced Studies, Australian National Univ., Canberra (1965) working no *Myrmeleotettix*, have suggested B-chromosomes as regulators of recombination at meiosis. Researchers have reported an increase in recombination between four genes on chromosome 3, which was directly proportional to the number of B-chromosomes. U. W. Ayonoadu and H. Rees (1968), Univ. College of Wales, Aberystwyth demonstrated that mean chiasma frequency in a variety of sweet corn, increases with an increasing number of B-chromosomes. J. P. Moss of U. K. (1966) reported that B-chromosomes increase seed weight, delay germination and decrease fertility in Transbaikal rye. It has been suggested by many workers that individuals possessing them in large numbers are comparatively weaker and less fertile. In rye, B-chromosomes show a deleterious effect and retain in population. Simultaneously recent researches also indicate that B-chromosomes show favourable phenotypic effect on plant when present in low number. It has also been reported by U. Nur of Deptt. of Biology, Univ. of Rochester, N.Y. (1966) that their number may be more harmful to male than to female in *Psuedococcus obscurus*.

So far as the origin of B-chromosomes is concerned, it is a cytogenetic dispute (Arne Muntzing, 1967, Institute of Genetics, Univ. of Lund, Sweden). In general, most of such chromosomes are heterochromatic. Some have been described as wholly or partially euchromatic. E. Battaglia of Italy (1964) believes that B-chromosomes originate from normal chromosomes due to fragmentation. This view was supported by a study where a correlation was drawn between occurrence of B-chromosomes and translocation heterozygote in Clarkia by K.R. Lewis (1968), Research School of Biological Sciences, Australian National University, Canberra. C. D. Darlington, Botany School, University of Oxford also suggests B-chromosomes as centric fragments or the telocentric arms of normal chromosomes. M. J. D White (1976) is of the opinion that fragments from normal chromosomes are converted into true supernumeraries as a result of successive duplication and perhaps by translocation from other chromosomes. Origin of B-chromosomes and their effects are still open questions and need special attention to unmask the facts.

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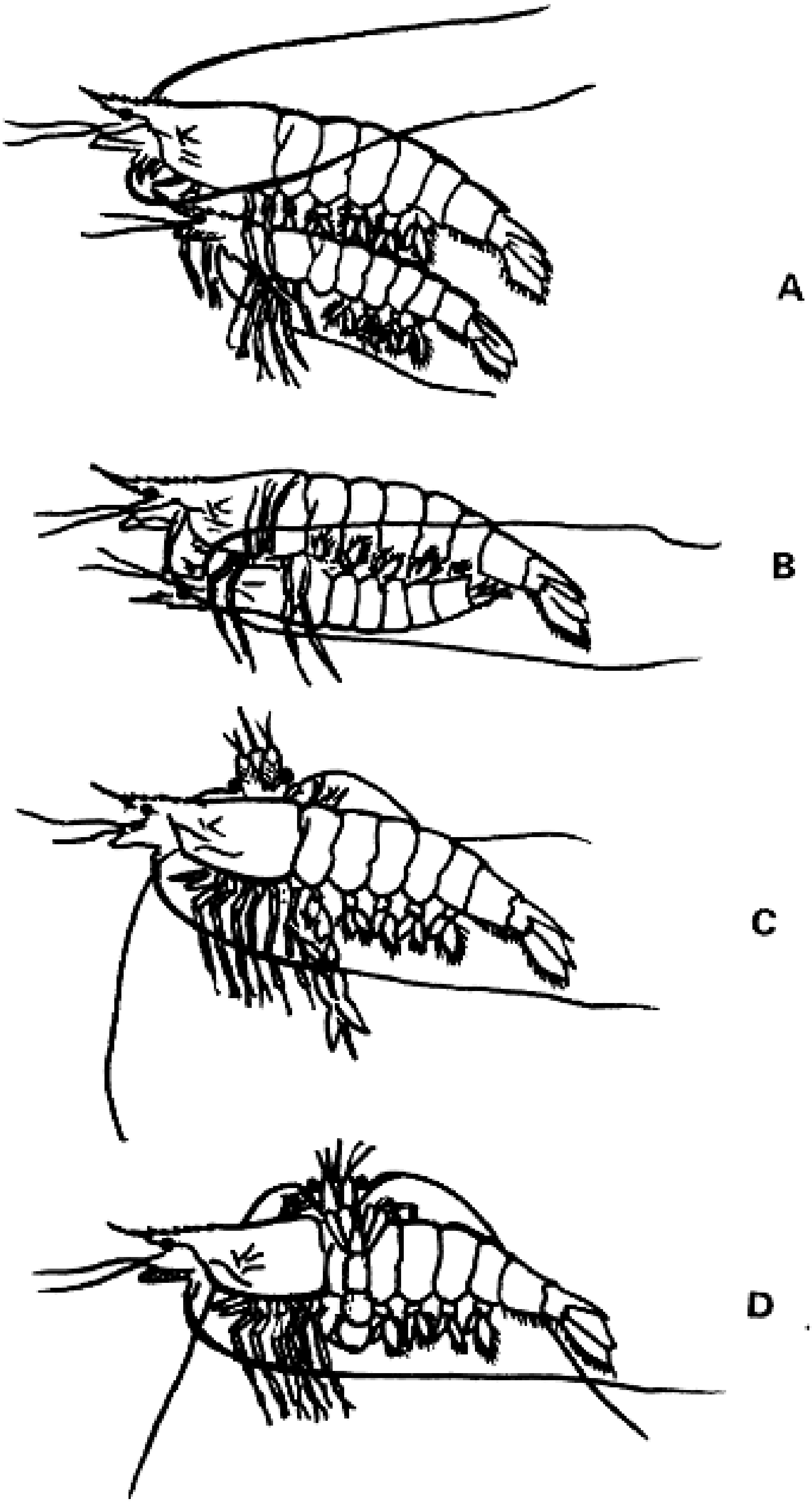
# How penaeid prawns reproduce

AS an item of marine product that is exported in thousands of tonnes, prawns fetch crores of rupees worth of foreign exchange every year. Among different groups, penaeid prawns form more than 50% of the total marine catch. The important commercial prawns which support the export are *Penaeus indicus* (Indian white prawn), *P. monodon* (Tiger prawn), *P. semisulcatus*, *Metapenaeus dobsoni*, *M. affinis*, *M. monoceros*, *M. brevicornis*, *Parapenaeopsis stylifera*, etc.

Prawns do not attain maturity in the estuary. (The offshore coastal areas are considered as the breeding ground for most of the commercial prawns.) Generally they migrate towards the sea for maturation and breeding and their postlarval stage return to the estuary which acts as their nursery.

Female and male prawns can be easily identified; females are generally larger than males in the same age group. Sex is determined by the presence of external genitalia. The female genitalia, the thelycum, is a flattened round-shaped organ located between the base of the last pair of walking legs. The spermatophores or sperm sacs from males are deposited into this organ during mating. In contrast, males possess a paired organ called petasma on the first swimming leg which helps in sperm transfer during copulation. The male genital openings are situated at the base of the fifth walking leg. In female the ovaries are situated dorsally, just below the exoskeleton. The fully mature ovaries are deeply coloured, thick and well defined in appearance and distinctly visible through the dorsal epidermal scales of the body. Female genital pores are seen at the base of the third walking leg.



**A. Female above-male below in parallel swimming; B. Male turns ventral side up and attaches to female; C. Male turns perpendicular to female; D. Male curves body around female and flicks head and tail simultaneously**

### Mating and spawning behaviour

Copulation between female and male prawn takes place at night and lasts for 3 to 4 minutes. A newly moulted female attracts one to three hard-shelled males who follow her as she makes brief upward swimming movements. One male is successful to position himself directly below the female. The pair then engages in parallel swimming movement during which the male turns to an upside down position, trying to attach his underside to that of the female. In the next phase the male quickly rotates from this alignment to a position perpendicular to the female, curves his body in a "j" shaped fashion around her and flicks his head and tail simultaneously. During the rotation or shortly afterwards the sperm sacs (spermatophore) are inserted inside thelycum.

Spawning takes place at any time of the year but mostly when the temperature is rising. (In controlled condition, spawning is noticed during early hours of the day.) Nearly 3-10 lakh eggs are released by a mature female prawn. Along with the eggs the female releases sperms from spermatheca (organ which receives and stores sperms) already present in its thelycum. Fertilization is external and occurs in the sea water.

### Hormonal interaction

Hormones play a vital role in the maturation and breeding of prawns. Neurosecretion of eye stalks is observed to contain two inhibiting hormones: (a) moult inhibiting hormone (MIH), and (b) gonad inhibiting hormone (GIH). These two hormones are antagonistic to moulting hormone (MH), secreted by the "Y" organ situated at the lateral side of head, and the gonad stimulating hormone (GSH) elaborated by the thoracic ganglion. In nature when the adult prawn migrates into the sea the hormonal effect of GIH is nullified by some unknown ecological factor. Removal of eye stalk neutralizes the effect of GIH and MIH and facilitates maturation and moulting. Artificially, prawns can be induced to mature by removing their eye stalks.

### Larval development

The larval history of penaeid prawns comprises four stages—nauplius, zoea, mysis and post-larvae. Each of these stages are further divided into sub-stages based on the number of moults that the larvae undergo in a particular stage. The detail of stages, their duration and the feeding habits of the larval forms are given in Table 1

Table 1

| *Larval stages* | *Duration* | *Food* |
|---|---|---|
| Nauplius ($N_1$—$N_6$) | 48 hrs—53 hrs. | Egg yolk |
| Zoea ($Z_1$—$Z_3$) | 6 days | Diatoms<br>Rotifers |
| Mysis ($M_1$— $M_3$) | 4 days | Diatoms<br>Rotifers<br>Brine shrimp<br>(Artemia) |
| Postlarvae | — | Algae,<br>Zooplankton |

Induced maturation, breeding and larval rearing of certain commercial prawns are being tried out in completely controlled conditions and the technologies have been standardised in countries like Japan, U S.A., Taiwan, Philippines and Tahiti. Hatchery systems have also been standardised in most countries where prawn culture has been taken up on an intensive scale. In India, studies on this aspect are still in its infancy.

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# Iodine deficiency and goitre

THE thyroid gland, located in the neck and having two lobes one on each side of the trachea, secretes several hormones but the principal one is thyroxine, an iodine-containing amino acid derivative. Thyroid physiology received its greatest stimulus when it was discovered that the enlarged thyroids (goitres), so commonly found among inland populations, were completely prevented by the administration of small quantities of iodine. Simple endemic goiters have been known since ancient times and are common where soil and water are low in iodine.

Before the practice of adding iodine to table salt came in to use, goitres were very common in Central Europe and the area around great lakes in the United States. Endemic goitre exists in numerous mountain-

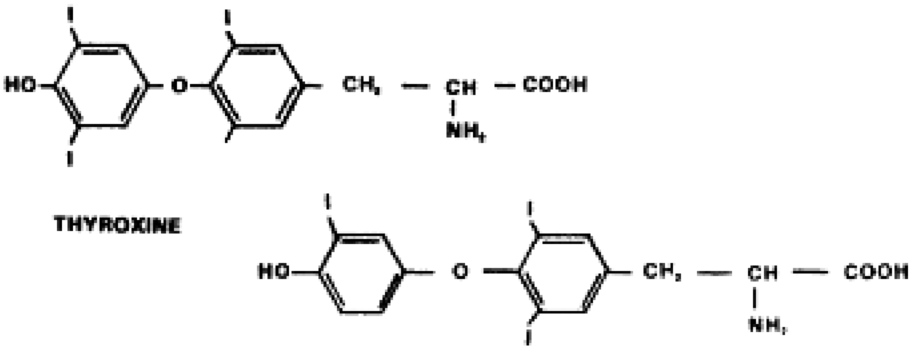

Fig. 1

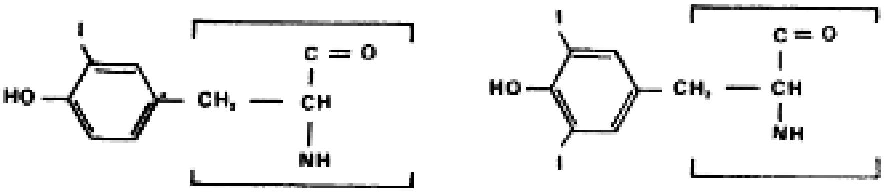

Fig. 2

ous areas of the world including the Andes, Central New Guinea, Switzerland and in many lowland areas such as the Baltic plains. According to official records, 10 per cent of the total population in Indonesia suffers from goitre. Most of the victims are poor and illiterate farmers who live in the mountainous regions where the soil contains little iodine. It was estimated in 1962 that 200 million people in the world suffer from iodine deficiency.

In areas where iodine deficiency is present, the incidence of palpable enlargement of the thyroid may vary in size from barely detectable to as large as the head. Since the swelling does not cause any pain, victims normally do not bother about it even though it may hamper swallowing. In some places monstrous enlargement of the thyroid is accepted as normal. The problems such as respiratory difficulty and of facial appearance may be associated with the thyroid enlargement. Severe iodine deficiency during pregnancy predisposes to cretinism which results from the incomplete development or congenital absence of the thyroid. An iodine deficient goitrous mother may give birth to a cretinous baby because the foetus requires an adequate secretion of thyroxine (of mother or foetal origin) during the later stages of pregnancy. This probably also predisposes to deaf-mutism and feeble-mindedness in the offspring. If cretinism is recognised shortly after birth, infants have a

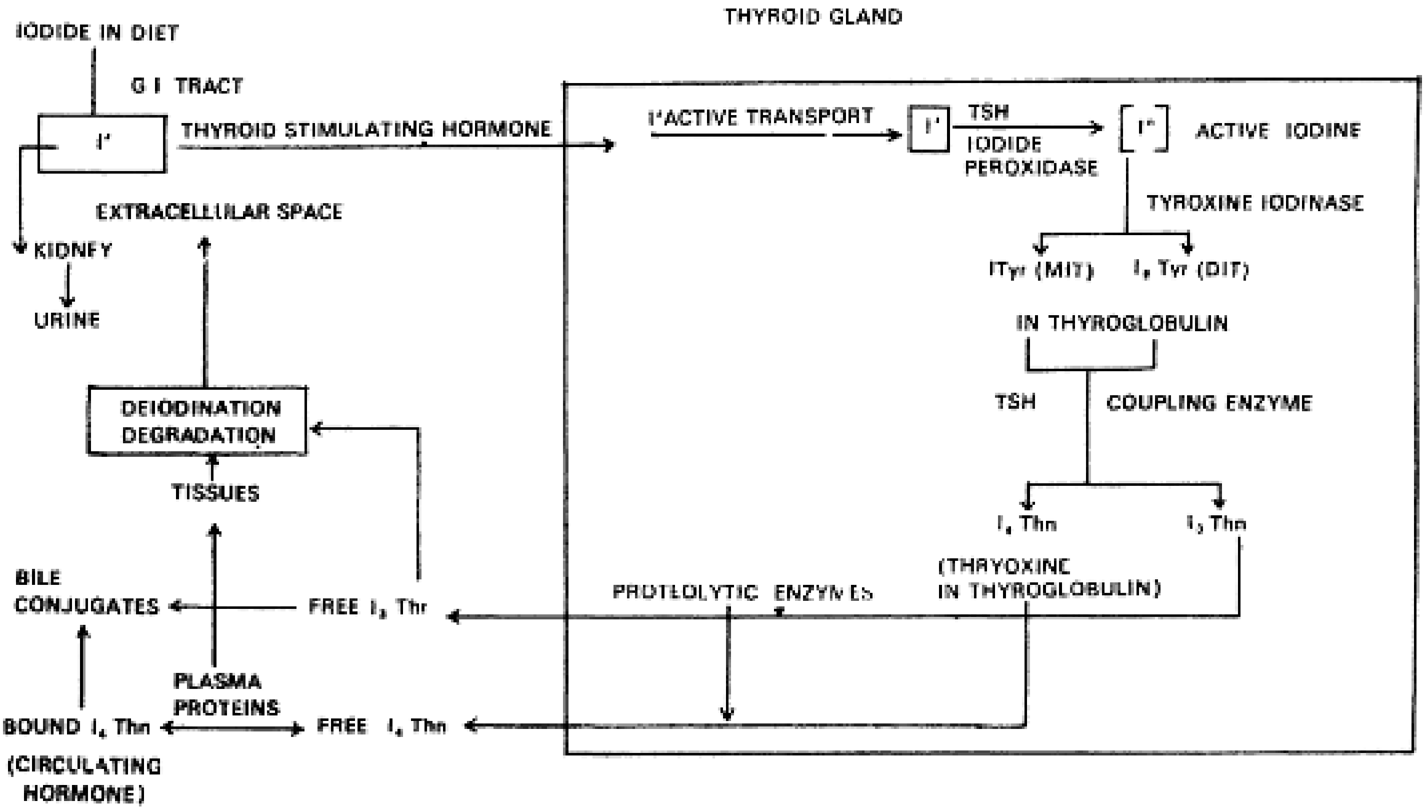

Fig. 3

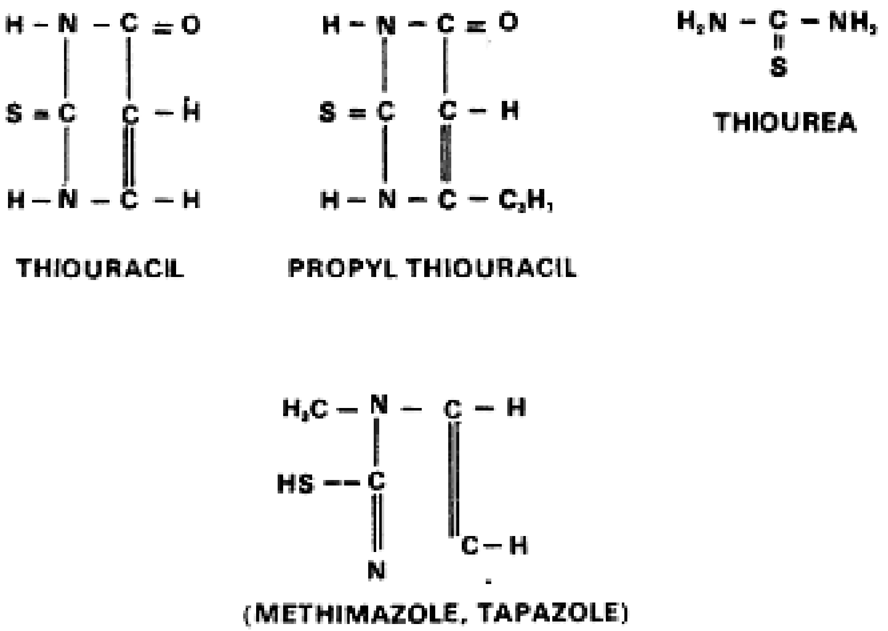

Fig. 3

typical appearance with increased hair, coarse skin, low forehead, puffy features, enlarged tongue and sluggish behaviour. Later other abnormalities may be detected; retarded growth, deaf-mutism, mental retardation and evidence of spastic paraplegia--a paralysis caused by spasms, i.e., paralysis of legs and lower part of the body due to involuntary contraction of muscles.

Endemic goitre has been eliminated in many areas of the world by compulsory addition of iodide to cooking and table salt and by supplementing iodide in school meals. The practical and administrative difficulties of iodine deficiency are greater in underdeveloped countries, though these are not insuperable if funds are available

Since iodine is an essential constituent of the thyroid hormones, it must be supplied in the diet. To prevent simple goitre, a dietary iodine intake of 100μg-200μg daily is sufficient for an adult. The regular use of iodized salt meets the requirement. The need of iodine is increased in adolescence and in pregnancy. Thyroid hypertrophy occurs if iodine deficiency is prolonged. Besides iodine, the diet must also supply the amino acids which are required for the synthesis of tyrosine, colloid globulin and plasma protein. The iodized table salt is the common salt which contains one part of sodium iodide in 100,000 parts of sodium chloride.

About 50 mg of iodine is present within the body of a man weighing about 70 kg. Probably all the cells of the body contain iodine. The concentration of iodine in the thyroid gland is remarkable, which accounts for as much as 70 per cent to 80 per cent of the total iodine content in the body. The iodine-containing hormone cannot be fabricated without available idoine. When the dietary iodine intake falls below 10μg/day, thyroxine synthesis is inadequate and thyroixne secretion declines leading to endemic goitres.

The iodine content of drinking water and the incidence of goitre show an inverse relation. Drinking water is not, however, an important source of iodine in the diet but it serves as an index of the iodine in the vegetation. The diagnosis of endemic goitre is best made by study of a population group. Its characteristic feature is reduced excretion of iodide in the urine. Use of radioactive Iodine ($^{131}$I) has shown that iodine from the blood stream is rapidly transported to the thyroid when it is used in the formation of thyroxine

Let us see how iodine and thyroid hormones are interrelated. Thyroid secretes thyroxine ($I_4$ Thn) and 3, 5, 3'-triiodothyronine ($I_3$ Thn), the two major iodine-containing compounds which are derivatives of amino acid, tyrosine (Fig. I). The latter can be produced from a wide variety of substances within the body and, therefore, offers no supply problem. Much of the iodine absorbed by the gastrointestinal tract ( which converts it to iodide, the ionized form of iodine) transported in the plasma in loose attachement to proteins by the thyroid cells, which manifest a remarkably powerful active transport mechanism for iodide. Thyroid-stimulating hormone (TSH, Thyrotropin) of the anterior pituitary stimulates iodide uptake by the gland. Once in the gland, the iodide is reconverted to an active form of iodine and is transferred to tyrosine by peroxidase. Thyrotropin is active in stimulating this reaction.

Iodine of the thyroid gland is present chiefly in thyroglobulin, a polysaccharide protein material. Iodination of tyrosine occurs first in position 3 of the aromatic nucleus and then at position 5, forming monoidotyrosine (ITyr) and diiodotyrosine ($I_2$ Tyr), respectively (Fig. 2). Two molecules of iodinated tyrosine then combine to give thyroxine, which becomes bound to thyroglobulin. Approximately, 20 per cent of the thyroglobulin-tyrosine residues are iodinated. The normal gland may store several week's supply of thyroxine in this bound form. Hormone release into the blood occurs by enzymatic splitting of the thyroxine from the thyroglobulin and later into the blood. The overall process is controlled by pituitary thyrotropin which stimulares certain key rate-limiting steps and thereby alters the rate of thyroxine secretion.

Thyroglobulin breakdown is directly inhibited by iodide. About 80 per cent of the hormone stored by the thyroid gland is thyroxine and 20 per cent, triiodothyronine. Most of the thyroxine in the blood becomes bound to certain plasma proteins and circulates in this form. The protein-bound thyroxine is in equilibrium with a much smaller amount of free thyroxine, the latter being the effective hormone. Finally, thyroxine may be removed from the blood and excreted by the liver and kidneys or inactivated by catabolism in many tissues. In liver, it is rapidly conjugated with glucuronic acid and, to a lesser extent, with sulphate and these inactive conjugates are excreted into the bile. Part of the conjugated thyroxine may be reabsorbed and transported to the kidney where it may be deiodinated or excreted as intact conjugate. The stages in the synthesis and release of thyroid hormones are illustrated in Fig. 3.

Goitre results from an absolute or relative low content of iodine in the diet. Thyroid disease also arises from the presence in the diet of substances (goitrogens) which interfere with thyroxine synthesis. Many kinds of plants, seeds and vegetables of *Brassicaceae* family, particularly cabbage and turnips, contain goitrogens which can produce goitres in animals. A factor present in water appears to be associated with an endemic goitre in Columbia. Thiocyanates are found in some root plants eaten in Central Africa. Potent goitrogens, related in action to the thioureas, are found in some plant species and are transmitted through cow's milk to humans in Tasmania and Finland. Some cases of goitre are due to thiourea compounds present in mustard which inhibit iodination required for the formation of the hormone. Certain compounds act as anti-thyroid agents and inhibit production of thyroxine both at the organification and coupling stages. In other words, these compounds inhibit the conversion of $I^1$ to $I^0$ and combination of monoiodotyrosine (MIT) and diiodotyrosine (DIT) to form triiodothyronine and thyroxine. Some examples of goitrogens are : thiouracil, propylthiouracil, methyl-thiouracil, carbimazole, thiourea and methimazole (Tapazole ) (Fig. 4).

Iodine deficiency sensed by the hypothalamus and pituitary, resulting in an increased secretion of thyrotropin and thyroidal clearance of plasma iodide. With this, there is also growth of thyroid gland which enlarges with hyperplasia (the abnormal multiplication or increase in the number of normal cells in normal arrangement in a tissue) and hypertrophy of the thyroid. Iodine administration returns the gland to normal size in a few weeks or months, unless, as in cases of long standing deficiency, the gland has undergone fibrosis (the formation of fibrous tissue). Although the treatment with sodium iodide should be adequate for the cases of simple goitre, thyroid hormone (L-thyroxine or desiccated thyroid) itself is more commonly used as there may be undetected defects in the pathway for the synthesis of thyroxine.

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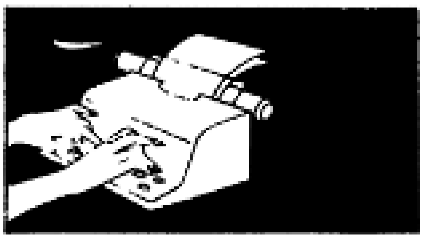

# NEWS & NOTES

## Indian Society for R & D Planning and Management

FIFTY Scientists, Administrators, Planning and Management Scientists gathered in CSIR on 6th July, 1980 to discuss the role and function of R & D Planning and Management Scientists in institutional and national development so that they may act as change-setters in the social complex of R & D organisations. They emphasised that, although the concepts of Planning and Management of R & D were being preached for a long time, their application to a realistic situation to improve it had been lacking. This is due to the fact that the practitioners in this field have not made the necessary efforts to keep themselves abreast with the latest developments in the field and adapt them in the context of their work. Unless, they do so they would not be able to act as catalyst to bring about a change in the value system of scientists, their organisation and its management.

Persons assembled felt that the interests of R & D planners, scientists and the organisations could best be promoted by forming a society.

They unanimously decided to form the Indian Society of R & D Planning and Management to ·

(i) consolidate and extend further the gains achieved in the concept and technique of planning and management of R & D (ii) make public aware of the implication of planning and management of R & D for national development; (iii) make scientists and technologists aware of the need for planning and management of R & D at institutional and national level; and (iv) to work for better and improved facilities for personnel engaged in planning and management of R & D and to develop capabilities and their more effective utilisation in developing R & D effectiveness.

The Society will provide a forum for discussion on factors connected with planning and management of R & D, science and technology policies, their implications for R & D system. The Society would also organise symposia, conferences and undertake publication, etc.

Any person residing in India and abroad working in the field of R & D planning and management or is interested in their promotion, will be eligible for primary membership of the society.

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## Effect of solar eclipse on human beings and animals

CONSIDERABLE work has been done by the Institute for Environmental Studies, a voluntary organisation situated in Rayalaseema of Andhra Pradesh. A team of young biologists headed by the author conducted studies on human beings with special reference to body temperature alterations, blood pressure, blood glucose levels and pulse rates. The studies were correlated with blood groups. The team also studied alterations in the behaviour of encephalitis affected children The results revealed that there is no drastic change in the temperature, pulse rate and blood pressure in all blood group systems except AB. In AB, there is a fall in body temperature, pulse rate and blood pressure. The blood glucose level showed an alteration in B and AB blood group people, while in others no alterations were observed. There is some blood group specificity versus response to meteorological alterations. Of course, at present no definite comment can be made.

The eclipse seems to provide some relief to those suffering from encephalitis. Very interestingly, we found that the frequency of fits rate and frequent crying and body irritations are reduced significantly when compared to the affected children who are not exposed to the eclipse. The exposed children started taking more food. However, there were no alterations in body temperature or blood pressure or in pulse rate.

The team also did some work on behaviour biology of hybrid jerssey cows in collaboration with scientists of Exotic Cattle Breeding Centre, Banavasi. It was found that there is an increase in body temperature and pulse rates. Urine excretion is also increased. They behaved as in the night at the time of totality. Milk was analysed for fat content which was found to decrease.

The scientists have also done some work on hydrobiology in relation to the behaviour of aquatic animals. During eclipse, they found high oxygen content in the pond, and except that there were no changes.

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# Acupuncture and antibodies

THE ancient Chinese science of acupuncture was enshrouded in complete mystery till recently. Two solid stepping stones have now emerged whence one can at least start to speculate and continue further experiments. The first of these is the discovery of endorphins, the natural opiates (*S.R.*, April 1980) which seem to be produced in enhanced quantities following acupuncture (Hokfelt *et al.*, *Proc. Natl. Acad. Sci.*, U.S., 74, 1977). This, indeed, may lie at the basis of the apparently inexplicable phenomenon of acupuncture analgesia, sometimes evident in major surgery without anaesthesia.

The second is the finding that acupuncture can indeed increase the γ-globulin or antibodies. It was noted that antibodies would begin to increase 2-7 days after acupuncture.

Our interest in this aspect stemmed from a visit of one of us (MG) to a Chinese hospital where bacillary dysentery was being cured with the help of acupuncture. We wanted to see the effect of acupuncture on γ-globulin. The experiments were performed on seven volunteers including one of us (RLB). None of these persons was suffering from bacillary dysentery or any other obviously massive infection. Electro-needling was performed on the same points used on the dysentery patients in the Chinese hospital.

We tried to obtain a preliminary series of data with the help of differential precipitation of γ-globulin following a standard procedure (Hawk, *Physiological Chemistry*, 1977). Serum was taken from the subject before and after acupuncture, at the same hour of the day. The γ-globulin was dissolved in 0.9% NaCl and the quantity estimated with a colorimeter. Experimental errors were determined by replicating aliquots of the same sample.

These comparatively crude results nevertheless indicate that in five subjects, acupuncture *decreased* the quantity of γ-globulin after three days. Needling was continued on the fifth subject and after the sixth acupuncture, a very significant increase was noted. The quantity of γ-globulin/ml now exceeded the original value. It further increased after nine days of needling (20% above the original). In the sixth and seventh volunteers, increased γ-globulin was noted after the tenth day. In four of these seven subjects the changes in γ-globulin far exceed the range of experimental error. The maximum change noted was in subject No. 7 (an increase of 25% above the original following ten days of acupuncture).

Further work is being undertaken with the technique of IgG and anti-IgG interaction in gel (Immunodiffusion). IgG is the major fraction of antibodies and the method of immunodiffusion is expected to be more rigorous.

Pending further investigations, the present data, though preliminary, that in persons of normal health, acupuncture can at first decrease and later increase the γ-globulin. This indicates an hitherto unexpected effect of acupuncture on the B-lymphocytes which synthesize antibodies and also on T-cells. Change in the composition of T and B-Cells after acupuncture has been recently reported (*Acupuncture and Electro-Therapeutics Research*, Vol. 3, 1978). As T cells produce comparatively large quantities of interferon, one may speculate on possible effects of acupuncture on interferon, as well! In any case, the effects of this ancient technique on the immune system opens up a new frontier of research.

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# Is betel nut carcinogenic ?

CARCINOGENIC means capability of an agent for producing cancer. Various agents have been recognized to possess carcinogenic activity in man and animals, although their mode of action towards formation of cancer might not be identical. These carcinogenic agents include :

(1) *Ionizing radiation*. It is well-known that leukaemia was most common in people of Nagasaki and Hiroshima exposed to radioactive fall-out following the detonation of atomic bombs in 1945. Maximal incidence of leukaemia in these people was related to the intensity of exposure. Apart from leukaemia, breast cancer was also prevalent among them. Scientists ultimately suggested that ionizing radiation plays an important role in the causation of carcinoma and called it as one of the carcinogens;

(2) *Chemical substances*. A number of chemical substances, viz., aromatic amines (present in cigarettes), metabolic product of tryptophan (an amino

acid), aflatoxin (produced from *Aspergillus*—a type of microorganism), nitrosamine (present in edible fruits are produced by fungi), etc., are marked as carcinogen since they can induce carcinoma in clinical and experimental cases;

(3) *Other factors*. Under this category come specific carcinogens not identified so far but whose existence is indicated by the following : presence of a special form of cancer in a population or a notably high incidence in a geographical region; a weaker association between cigarette smoking and carcinoma of the larynx and carcinoma of the bladder; breast cancer is more common to mothers who do not breast-feed their babies or use continuously padded bra (*S.R.*, Nov. 1979) ; a higher incidence of cancer of uterine cervix in prostitutes but the lowest incidences in nuns. Cancer of the lip was associated with smoking with short clay pipes.

Research related to carcinogenic activity of different plants and fruits has revealed that betel nut can produce carcinoma. Scientists demonstrated in early sixties that epidermal cancer of the buccal cavity could result from regular chewing of substantial quantities of betel nuts. This observation was confirmed by workers from different laboratories (*Planta Med* (*Suppl.*), Vol. 16, p. 13, 1968; *Ind. J. Cancer*, Vol. 17, p. 469, 1976). A group of scientists from Biology Division, Cancer Research Institute, Tata Memorial Centre, Bombay recently undertook the problem in a more systematic way. Subcutaneous injections of hot and cold aqueous extracts of dried Mangalore areca nut by them produced 60% fibrosracoma in swiss strain mice. They then fractionated the betel nut constituents by solvent extraction process. Aqueous and polyphenol extracts of betel nut were prepared and injected into the mice in order to study the mode of action of these fractions towards carcinogenicity. Different biochemical parameters, viz., protein, nucleic acid, glycogen, sialic acid, etc., were measured in liver, kidney, lung and muscle tissues of the mice. Results indicated that polyphenol fraction decreased nucleic acid and protein contents in almost all the tissues. Further, decreased concentration of glycogen and increased concentration of sialic acid in lung and kidney were observed after treatment with betel nut extracts. These results, according to them (*Ind. J. Pharmacol.*, Vol 10, p. 191, 1978), were comparable considering the mode of action of other recognised carcinogens. To understand the precise mechanism of betel nut towards carcinogenicity, these workers extended their studies on the effect of different constituents of betel nut on sulfhydryl metabolism since established carcinogens are known to form complexes with sulfhydryl group compounds, e.g., enzymes and thus alter metabolic reactions. They injected aqueous and polyphenol extracts of betel nut and arecoline (an important alkaloid of betel nut) into mice and measured glutathione, protein-SH and protein-SH+S—S contents in liver, lung, kidney and muscle tissues of the animals. Different extracts of betel nut increased glutathione content and decreased protein-SH content in almost all the tissues. Arecoline, however, showed a decreased content of glutathione in the tissues they studied (*Ind. J. Pharmacol*, Vol. 10, p. 257, 1978).

Preliminary experiments in author's laboratory also support the above findings. It is believed that betel nut, in addition to the above mechanism, causes carcinogenicity by affecting the normal synthesis of mucosubstances in the experimental animals.

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# Resonance and its applications

THE idea of "resonance" is one which has played a prominent part in the progress of chemistry in general and organic chemistry in particular. The concept of resonance originated in 1933 from the electronic theory of valency of G. N. Lewis and its subsequent refinement by wave mechanics. It was observed that in cases of many substances, especially organic compounds, a single conventional structure could not satisfactorily explain all the properties of that substance. So the idea gradually emerged that a molecule of such a substance can be represented by more than one structure. This was permitted by the electronic theory of valency and the wave mechanical developments.

It is possible to assign a molecule more than one electronic structure which differ only in the average distribution of valency electrons but not with respect to the positions of the constituent atomic nuclei, with the structures having more or less the same energy. In that case the normal state of the molecule cannot be satisfactorily represented by any one of the structures but is satisfactorily represented by a combination of the various structures or an intermediate of the various structures which is called the "hybrid" structure. The molecule, in turn, is said to resonate between the various structures and the normal state of the molecule is called the "resonance hybrid". It is not a mixture of the various structures but consists of a single kind of molecules possessing to some extent the characteristic properties of all the structures (Lewis and Calwin). The various structures are said to contribute to the resonance hybrid.

There is an interesting analogy for the clear understanding of a resonance hybrid. A mule is a hybrid of a horse and a donkey. Taking the structural side alone, the structure of a mule is derived by the combination of the structures of a horse and a donkey. Or, the structure of a mule can be said to be intermediate between that of a horse and a donkey. By this statement, it does not mean that the mule is having the structure of a horse for some time and that of a donkey for some other time, constantly transforming from one structure to another. It does not also mean that at a given interval of time, some mules are having the structure of a horse and some others are having the structure of a donkey. But it means that a mule is a distinct type of animal with a characteristic structure of its own even though that structure is derived by the combination of the structures of a horse and donkey.

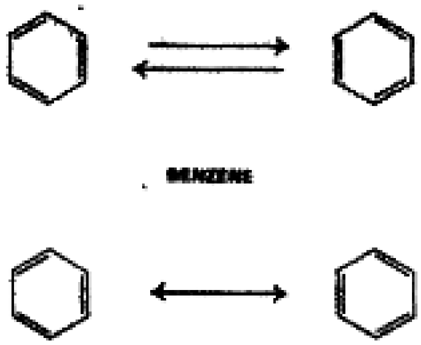


Fig. 1

Let us take the example of benzene and study the normal state of the molecule of benzene. Benzene molecule was represented by Kekule's two oscillating structures as shown in Fig. 1. (top). After the idea of resonance came into scene, the normal state of the molecule of benzene was taken to be the resonance hybrid of the two structures and represented by a double-headed arrow in between (Fig. 1, bottom). These two structures satisfy the condition of resonance that

$HCl \qquad H{:}Cl \longleftrightarrow H^{+}Cl^{-}$

$CO_2 \qquad \overset{+}{O}\equiv C-O^{-} \longleftrightarrow O=C=O \longleftrightarrow \overset{-}{O}-C\equiv O^{+}$

$CO \qquad C=O \longleftrightarrow \overset{-}{C}\equiv O^{+}$

Fig. 2

there should be a change only in the distribution of electrons and no appreciable change in the position of the atomic nuclei. Some other structures also are possible for benzene but their contribution is not significant.

By saying that the normal state of the molecule of benzene is a resonance hybrid, one has to visualize an intermediate structure between the two structures suggested by Kekule and having a bond intermediate between a single and a double bond. That would be a 'one-and-a-half-bond', and since this does not sound well, it is called "Benzene bond". Such a bond is possible because a bond is not a rigid structure but a representation of mobile electrons. The average distribution of electrons between any two carbon atoms in benzene would be greater than what it would be if the carbon atoms are linked by a single bond and less than what it would be if they are linked by a double bond. In fact, interatomic distance measurements have proved this and the bond length is intermediate between the length of carbon-carbon single bond and that of carbon-carbon double bond. The bond length between any two carbon atoms in benzene is 1.39 Å which is intermediate between 1.54 Å (length of typical C—C single bond) and 1.33 Å (length of typical C = C double bond).

Some other chemical molecules which are said to resonate are given in Fig. 2.

### Resonance energy

Molecules having a number of resonating structures are stabilized by resonance energy which is the energy of the stable resonating structures minus the energy of the resonance hybrid. Resonance energy is always positive because the hybrid has less energy than any of the resonating structures. Hence the resonance hybrid is more stable than the most stable of the resonating structures. The resonance energy is determined by thermo-chemical studies, e.g., heats of formation, heats of combustion and heats of hydrogenation.

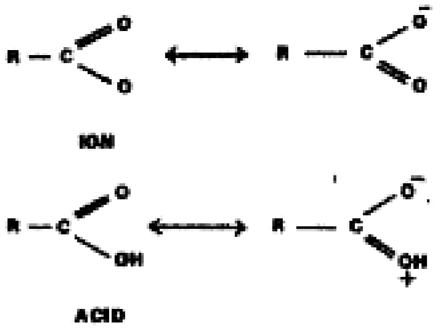


Fig. 3

The experimental values of heats of formation of compounds which resonate are always greater than the theoretical values of heats of formation calculated by adding the individual heats of linkages. In benzene, the observed heat of formation is 39 K cals more than the calculated heat of formation. The observed heat of formation of benzene from gaseous atoms is 1038 K cals but the sum of energies of six C—H (87 × 6), three C—C (59 × 3) and three C = C linkages (100 × 3) is only 999 K cals. This difference of 39 K cals is the resonance energy which stabilizes the molecule of benzene. On the other hand, the heat of combustion of a resonating substance as experimentally determined is less than the theoretically calculated value by an amount equal to the resonance energy. Similarly, the heat of hydrogenation of benzene as found by experiments is 36 K cals less than the calculated value.

Experimental evidences for resonance are: chemical properties which usual conventional structures cannot explain; interatomic distances and shortening of bond distance; resonance energy from thermochemical data, namely, heats of formation, combustion and hydrogenation and force constants from Raman spectra and infra red spectra and dipole moment. If two significantly contributory structures of molecule have opposite dipole moments (as in the case of carbon dioxide), the resulting moment is zero.

Resonance is also able to explain many observations and reactions which were earlier ill-understood. Resonance explains the exceptional stability of the aromatic ring even though the nucleus is said to contain double bonds. It also explains their lack of properties typical of unsaturated hydrocarbons. It explains various organic reactions in general and aromatic substitution in particular.

It explains why organic acids behave as acids, how ionization and liberation of hydrogen ion is possible in a covalent compound like the carboxylic acid. The carboxylate ion reso-

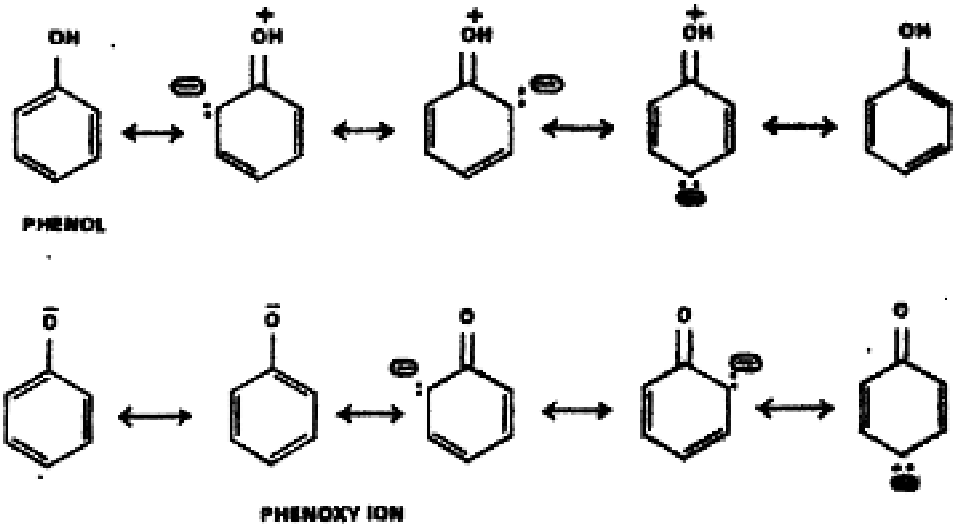
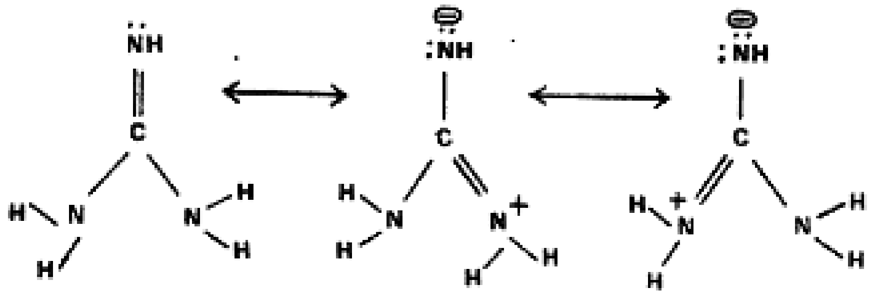
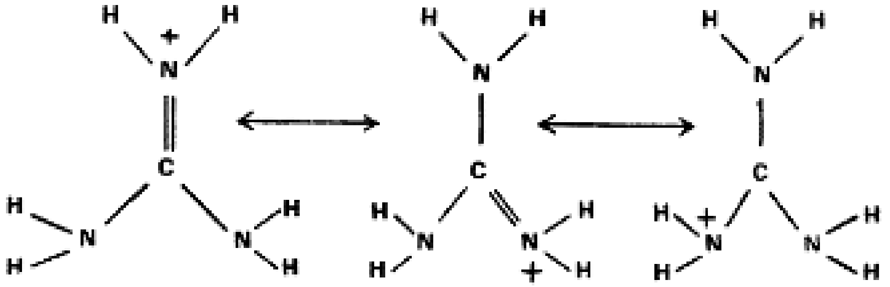


Fig. 4



GUANIDINE



GUANIDINIUM ION

Fig. 5

nates between two equivalent structures while the resonating structures of the undissociated acid are not equivalent; one of the latter has charge separation (Fig. 3). As the resonance energy of carboxylate ion is greater than that of the acid , the ion is more stable than the acid. Hence, there is ionization. Likewise phenol is acidic because of phenoxy ion is stabilized by greater resonance energy than phenol molecule (Fig. 4).

The basicity of substances like guanidine can be explained in terms of resonance. The guanidinium ion has equivalent structures and hence greater resonance energy than guanidine. As a result guanidine easily forms the ion by accepting a proton and thus behaves as a base (Fig. 5).

The stability of free radicals is also due to resonance between several equivalent structures, e.g., triphenyl methyl $(C_6H_5)C\cdot$ resonates between 9 structures and hence is very stable.

Resonance also explains the brilliant colour of organic compounds, especially the organic dyes. The intense colour is due to resonance between two equivalent or nearly equivalent structures which have large dipole moments and which can be easily raised to an excited state. During transition from the normal to the excited state, there is absorption of light which gives rise to colour. Since dipole moments should be larger, nitrogen and oxygen atoms have a significant role.

There are many more applications. In fact, in the book *Nature of the Chemical Bond*, Linus Pauling even predicts the applications of resonance to biological processes and physiological phenomena like the contraction of muscle and transmission of nerve impulses along the nerves and in the brain. There is hardly an area where knowledge of resonance is not applied in understanding the nature of a substance or the mechanism of a reaction.

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# Exercise—how and why ?

THE human body is made up mainly of bones, muscles and fat. Some 639 different muscles account for about 45% of the body weight Each of these muscles has four distinct and measurable qualities which are of interest to us. A muscle can produce force which can be measured as strength of muscle. It can store energy which permits it to work for extended periods of time independent of circulation (this is generally referred to as muscular endurance); it can shorten at varying rates (called speed of contraction); and it can be stretched and will recoil (elasticity of muscle). The combination of these four qualities of muscles is referred to as muscular power.

If muscles are to function efficiently, they must be continually supplied with energy. This is accomplished by blood which carries oxygen from lungs and nutrients from digestive system to the muscles. The combined capacity of the body to supply energy to the working muscles is called organic power. The capacity and efficiency with which our body can function depends on the degree of development of our muscular as well as organic power through regular exercise. However, the level to which we can develop these powers is influenced by such factors as the type of body we inherit, the food we eat, presence or absence of disease and rest and sleep. We are physically fit only when we have adequately developed our muscular and organic powers to perform with highest possible efficiency.

### Exercise and physical fitness

Heredity and health determine the top limits to which the potential physical capacity of an individual can be developed. This potential capacity varies from individual to individual. The top level at which a person can perform physically is called "acquired capacity" because it has been acquired or developed through daily physical activity. Our body, like a car for example, normally functions efficiently well below its acquired capacity. A car driven at its top speed of, say 175 kilometers per hour consumes more gasoline per kilometer than when it is driven around 80–96 kilometers per hour, which is well below its top capacity. Our body functions in the same way in that the ratio of work performed to energy expended is better when it functions below acquired capacity. We can avoid wastage of energy by acquiring a level of physical capacity well above the level required to perform our normal daily tasks. This can be done by supplementing our daily physical activity with a balanced programme of regular exercise. Our capacity increases as we progressively increase the load on our muscular and organic systems. Exercise thus increases physical endurance and stamina and provides a greater reserve of energy for leisure-time activities.

Muscles, unless adequately exercised or used, become weak and inefficient and get easily tired. Weak back muscles are associated, in many cases, with lower-back pain. It has been estimated that 90% of these backaches may be eliminated by increasing the strength of the back muscles through exercise. The efficiency and capacity of the heart, lungs and other organs can be improved by regular and vigorous exercise. A fit person is less susceptible to common injuries, and if injured, recovers more rapidly. Persons who had a physically active life have less risk of getting degenerative heart diseases. Regular, vigorous physical activity can also help in reducing emotional and nervous tension.

Regular physical exercises also have a long-term protective effect on the cardiovascular (heart and blood vessels) system and possibly reduce the level of cholesterol in blood. A further advantage of regular exercise is that it stimulates the general physiology of the body, especially the functions of the circulatory system, the respiratory system, and the excretory system.

### Exercise—why, how and what kind ?

The change from a state of rest to one of active movement of the body involves changes in the activity of most of the body system. When active exercise ceases these changes are reversed and the body's functions resume their resting state. With frequent, repeated exercise (physical training) the adaptation to the state of physical activity improves and the return to the resting state after exercise is more rapid. The term "training" without qualification denotes general physical training designed to develop agility, strength, and endurance of the whole body rather than of the particular muscle groups required for particular activities. Such general physical training has important and measurable physiological effects. The primary object of training is to improve the performance of physical work. A given task is performed with less expenditure of energy by a trained person than by an untrained person and the total work capacity is increased. A general programme of physical education improves the capacity for most forms of exercise but special training for particular tasks may also be useful.

Appropriate physical activity in childhood develops the muscles, promotes good posture, improves neuro-muscular coordination, and increases the capacity of the circulatory and respiratory systems to deal with the demands of muscular exercise. Habitual exercise prolongs life and gives some protection against the diseases associated with a too sedentary life. These include obesity, backache due to poor muscle tone, constipation, varicose veins, and coronary heart disease, which is commoner and tends to be more severe in inactive individuals. Regular exercise is particularly important for the middle aged and elderly because it delays the physical deterioration associated with advancing age.

Vigorous exercise can be considered useful upto the age of 30 to 40. Thereafter, it can do more harm than good. But increasing age should be no bar at least to some regular forms of physical activity within the range of one's own physical capacities. The amount of fatigue produced is probably the best measure of the exercise that ought to be taken. The ability to recuperate after exercise is a good guide at any stage. Recuperation should be reasonably prompt. If breathing and heart rates remain higher than normal at the end of ten minutes after exercise; or there is marked weakness or fatigue persisting after a two-hour rest period; restlessness with broken sleep after retiring for the night; or a sense of definite fatigue on the following day, the exercise has been too severe or too prolonged for that person in his present stage of physical training and strength.

The best choice of exercise is that which gives the most satisfaction. Recreation has been defined as "acivity for pleasure". It achieves relaxation of mind and muscle. The range or recreational exercises is far broader than most people think. Some of them are: walking, swimming, dancing, skating, rowing, fencing, bicycling, horse riding, tennis, squash, handball, softball, volleyball, badminton, skiing, sailing, hunting, archery, bowling, fishing, gardening, croquet, hiking, climbing, and golf. Walking is the most flexible and natural of all forms of exercises. The rhythms of dance can afford release of emotional and psychosexual tensions. There is an advantage in learning sports and obtaining reasonable proficiency at games that one can play for fun for many years after college.

Reducing exercises are those which help to distribute the body fat and cut down hip measurements, but they are of little value for losing weight. Vigorous exercise immediately after a meal is bad. Among the effects of exercise are changes in the distribution of blood and depression of gastric secretion. These effects are related to the excitement of competition as well as to sheer physical activity. Heavy exercise after meals appears to interfere with digestion. Rest, or very light exercise like leisurely walking after meals, is beneficial.

The essence of isometric exercise is the practice of muscular contractions to the utmost of one's ability maximum bursts of efforts for for a brief period of time, usually 6 to 15 seconds. We push, pull, press, or lift against an object that does not move because of the lack of or little movement connected with them, isometric exercises are also called "static" exercises. This is in contrast to the better-known types of calisthenics, described as "dynamic", "ballistic" or "isotonic" exercises, all of which involve considerable free body movement. The principal outcome of isometric exercise is to increase the strength of the muscles exercised. It does so by an increase in muscle tension.

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# U—D numbers

UPSIDE - Down numbers are those which, when placed upside down, are still numbers. Take, for example, the number 6. When placed upside down, this gives the numbers 9. The basic U-D numbers, i e., upside down numbers, are 1, 6, 8 and 9. All the U-D numbers in the number system are composed of these numbers.

The basic ten numbers of the number system can be obtained from the above U-D numbers as follows:

$0=9-8-1$,
$2=8-6$,
$3=9-6$,
$4=9-6+1$,
$5=6-1$,
$7=6+1$,

while the numbers 1, 6, 8 and 9 stand for themselves.

The average of the basic U-D numbers is $24\div4=6$, which is an U-D number. The average of the four numbers formed of the above numbers taken two at a time in cyclic order is $(16+68+89+91)\div4=66$, while that of the four numbers taken three at a time in cyclic order is 666, which are again U-D numbers. Similarly, the average of the four numbers taken all at a time in cyclic order is 6666.

The numbers 1, 6, 8 and 9, when placed in an ascending order, form the number 1689. It can be obtained by using the basic U-D numbers as follows:

$$1689=1+6^3+8^3+9^3+8\times(9+6)\times(8-6)-9.$$

There are some U-D numbers which can be obtained from other U-D numbers. For example,

$16=88-8\times9$,
$18=66-6\times8$,
$89=98-9$, etc.
and
$161=169-8$,
$868=869-1$, etc.
Also
$1188=198\times6$,
$66=8\times9-6$,

$$18=\frac{1\times6\times8\times9}{1+6+8+9}, \text{ etc.}$$

## Some palindromes of U-D numbers

Palindromes of numbers are those which are the same numbers when read from the right hand or the left hand side. For example, the numbers 121, 333 and 505 are Palindromes. There are some Palindromes of U-D numbers which can be obtained from the U-D numbers. These are,

$181=6^2+8^2+9^2$,
$6666=69\times96+6\times(6+1)$,
$9669=98^2+8^2+1$,
$11911=6^4+8^4+9^4-6^2-6$,
$99699=6^5+8^5+9^5+8^2+6^2+6$.

Also

$$\frac{16+68+89+91}{1+6+8+9}=11,$$

$$\frac{168+689+891+916}{1+6+8+9}=111,$$

$$\frac{1689+6891+8916+9168}{1+6+8+9}=1111,$$

$$\frac{16891+68916+89168+91689}{1+6+8+9}=11111,$$

and

$$\frac{168916+689168+891689+916891}{1+6+8+9}=111111$$

Similarly, Palindromes with higher digits can be obtained.

**Other palindromic numbers**

There are other Palindromic numbers which can be readily obtained from the U-D numbers. These are as follows:

$252=16^2-9+6-1,$

$323=18^2-1,$

$363=19^2+8-6,$

$979=16\times 61+9-6,$

$1221=19\times 68-9\times 8+1$

$\quad=18\times 69-8\times(8-6)-6+1,$

$1441=18\times 81-8-9$

$\quad=16\times 89+8+9,$

$3773=61^2+6\times(9+1)-8,$

$4664=68^2+8\times(6-1),$

$4774=69^2+8+6-1,$

$5885=68\times 86+6^2+1,$

$5995=61\times 98+8+9,$

$7337=86^2-6\times(9+1)+1,$

$7447=86^2+9\times(6+1)+6,$

$7777=81\times 96+1,$

$7887=86\times 91+6\times(9+1)+1,$

$7997=89^2+8\times 9+9-6+1,$

$8228=91^2-6\times 9+1,$

$8778=89\times 98+8\times(6+1),$

$9229=96^2+8+6-1,$

$841148=6^6+8^6+9^6+6^3+9^3-6^2-8+6,$

$7160617=6^7+8^7+9^7+8^3+8\times 6,$

$61500516=6^8+8^8+9^8-8^3\times 6+6^2-1,$

and

$531717135=6^9+8^9+9^9+8^3\times 6-8$
$\quad\times 6-8+6$

In this way, a good many numbers of palindromic numbers can be obtained from U-D numbers.

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# Science quiz

1. With which of the following microscopes have colour films of atoms been made?
   (a) Ion field emission microscope
   (b) Electron microscope
   (c) Scanning electron microscope
   (d) Scanning transmission electron microscope

2. The "Big bang theory" of the creation of the universe was put forward by
   (a) Edwin Hubble in 1925
   (b) Georges Lemaitre in 1927
   (c) Alan Sandage in 1965
   (d) Gold, Bondi and Hoyle in 1948

3. Which of the following planets is not visible to the unaided eye?
   (a) Saturn
   (b) Jupiter
   (c) Uranus
   (d) Mercury

4. Which of the following names is associated with cybernetics?
   (a) Norbert Wiener
   (b) Kamerlingh Onnes
   (c) Eugene B. Wigne
   (d) Polykarp Kusch

5. The moderator used in a fast breeder nuclear reactor is
   (a) graphite
   (b) liquid sodium-potassium alloy
   (c) heavy water
   (d) moderator is not used

6. Light coming from Proxima Centaurus—the closest star in the night sky—takes the following time to reach the earth
   (a) 4.25 years
   (b) 3.60 years
   (c) 6.25 years
   (d) 5.35 years

7. Galois, the famous mathematician who died young, was chiefly associated with
   (a) number theory
   (b) set theory
   (c) group theory
   (d) topology

8. The planet Mercury is the closest in size to which one of the following satellites?
   (a) Ganymede of Jupiter
   (b) Titan of Saturn
   (c) Triton of Neptune
   (d) Moon of Earth

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**Answers to the science quiz**

(1) d, (2) b, (3) c, (4) a, (5) d, (6) a, (7) c, (8) a

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## Corrigenda

1. Re: S. R., August 1980 page 510 Author of the article *How reproduction is controlled by hormones* is Chandrima Shaha.
2. Re S.R., August 1980, p 543, Column 2, para 2, 12th line. Please *read* ellipse shaped *for* eclipse shaped.
3. Re: S R., July 1980, *Gems—natural and man made* page 463, 1st column, 14th line *read* 1 carat=200mg for 1 carat=200gm

# FOR HER

## Nutrition for normal vision

MALNUTRITION is one of the many reasons of blindness in humans. Lack of a specific nutrient may cause blindness, which may be prevented if diagnosed and treated early. Every year at least a million children become blind due to vitamin A deficiency, specially in underdeveloped and developing countries. We should, therefore, see what are the nutrients required for normal functioning of the eye and how their deficiency affects it.

### The human eye

An adult human eye is almost spherical in shape (Fig. 1). It is enclosed in a bony cavity, cushioned on a thick layer of fat. The eyeball consists of membranes, a crystalline lens, a vitreous body and the aqueous humour. The eyelids are covered by a delicate membrane called conjunctiva which stretches over the eye and covers it. Surface of the eyes is kept moist by the tear fluid secreted by lachrymal glands.

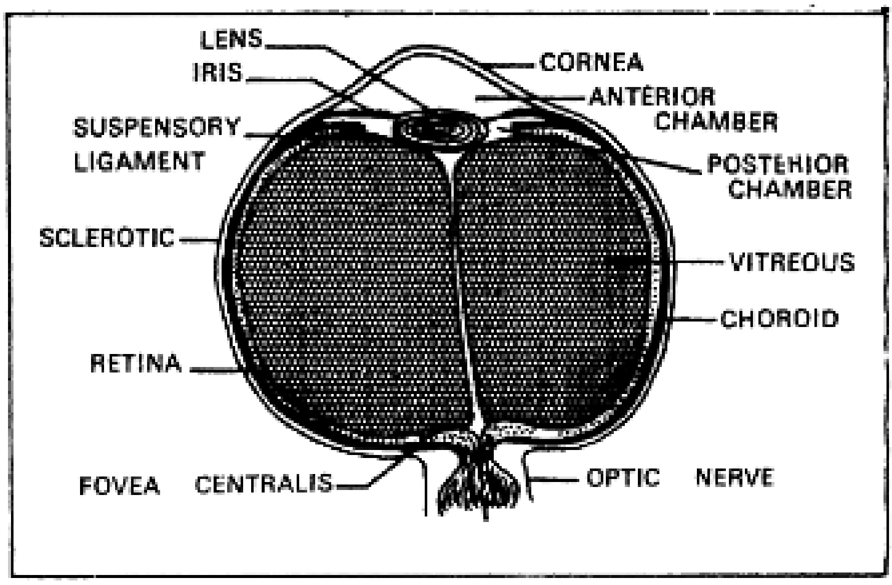

**Fig. 1. Structure of the eye (Reproduced from: *The Human Body*, Best and Taylor)**

Wall of the eye is composed of three layers; an outer, a middle and an inner. The outer layer consists of two parts: the anterior, called cornea, and the posterior called sclera. Cornea is supplied with sensory nerve endings and sclera with blood vessels. The middle layer carries a fine network of blood-vessels and contains pupil, the coloured part of the eye. The innermost layer of the eye or retina contains several membranes which convert energy of light waves into nerve impulses. The latter are transmitted by the optic nerve to the brain to make us 'see' an object.

### Vitamin A and vision

Rods and cones located in the retina are receptors of vision. Rods are numerous in number, about 100 million. They are concerned with vision in dim light. Cones are comparatively few in number, about 7 million, and are responsible for colour-vision and vision in bright light. Rods contain a pigment called rhodopsin or visual purple. This pigment is made up of protein fraction scotopsin and vitamin A aldehyde fraction known as retinene or retinal. 11 *cis*-retinene unites with opsin to form rhodopsin. Cones also contain a pigment known as visual violet which is made up of iodopsin, a (protein) and 11 *cis*-retinene.

Vitamin A alcohol is oxidized to vitamin A aldehyde in the epithelium of rods by alcohol dehydrogenase in the presence of nicotinamide adenine dinucleotide. Here, protein and retinene combine to form rhodopsin. Light initiates a series of photochemical changes in rhodopsin, beginning with bleaching of the purple pigment and ending with the formation of all-*trans*-retinene and its isomers. Retina is able to isomerise all-trans form to *cis*-trans form. This is essential as the resynthesis of retinene is isomer-specific. Besides this, vitamin A is also essential for the integrity of mucus secreting cells of epithelial tissues. In its deficiency epithelial tissue is keratinized.

One of the first symptoms of vitamin A in deficiency is night-blindness. The deficiency may be due to either inadequate intake or absorption of vitamin A or carotene, which is precursor of vitamin A, or it may also be due to ineffective conversion of vitamin A into its metabolities and defective utilization. Sometimes, other vitamins such as riboflavin, thiamine, niacin, ascorbic acid or certain amino acids also bring about recovery when vitamin A alone fails to alleviate night-blindness.

If night-blindness is left untreated, it progresses to further degeneration of the eye. In xerosis conjunctivae, the bulbar conjunctiva presents a dry appearance. Gradually wrinkles and folds appear and they give a smoky appearance because of diminished transparency of epithelial tissue. The dryness spreads to cornea (xerosis cornea) which may become dull hazy or non-lustrous in appearance.

Another common sign of vitamin A deficiency is the appearance of Bitot's spots. They are white, elevated, sharply outlined triangular patches covered with material resembling dried foam. Lesions resembling Bitot's spots have been observed in some cases in tropical countries which, however, are not due to vitamin A deficiency.

The final stage of vitamin A deficiency manifests itself in keratomalacia (total softening of cornea). A change in cell structure and total degeneration of corneal epithelium occur producing opacities, and the cornea becomes vasculatized, oedematous and infiltrated with leucocytes. Death of cells leading to ulceration and bacterial invasion brings about destruction of the cornea. Blindness often results from corneal scarring or perforation. Although epithelial damage is always encountered in vitamin A deficiency, the mechanism of this phenomenon is not known.

### Vitamin A and protein deficiency

Xerophthalmia is usually encountered in children suffering from Kwashiorker (protein-energy malnutrition) as a secondary deficiency. Protein deficiency may interfere with the normal absorption of vitamin A by decreasing synthesis of enzymes needed for its absorption. The transport and mobilization of absorbed vitamin A is reduced in protein-deficient children.

Our dietary source of vitamin A is its precursor—carotene—present in green and orange-yellow vegetables. Westerners obtain it from animals. In protein deficiency, conversion of carotenoids to vitamin A is lowered.

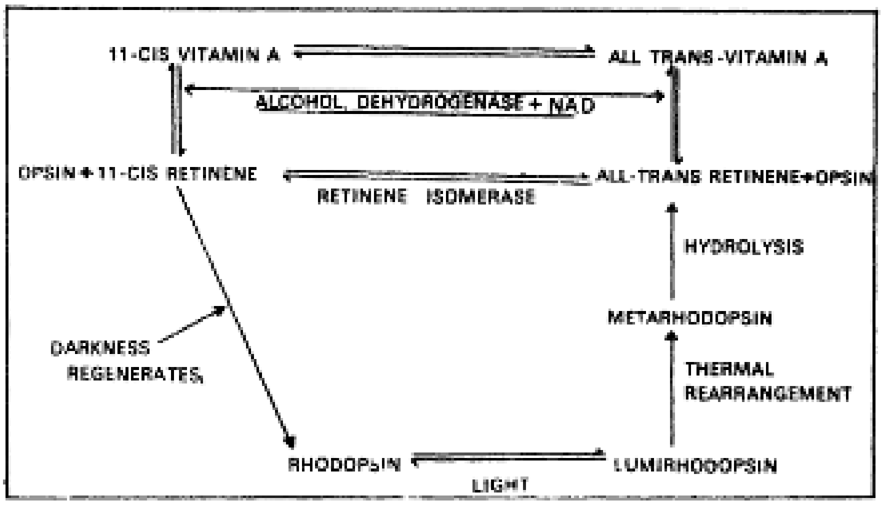

**Fig. 2. Vitamin A visual cycle (Reproduced from:** *Essentials of Food and Nutrition*, **Swaminathan)**

In experimental animals a condition known as 'nutritional corneal dystrophy' is observed when they are fed with diets deficient in essential amino acids. The disease is characterized by corneal vascularity which closely resembles riboflavin deficiency. However, this is rarely observed in man. In growing animals, the state of refraction is influenced by dietary source of protein, protein of animal origin being more beneficial. Based on this observation the course of myopia in children and adolescents can be modified to certain extent by dietary means.

### Riboflavin

Riboflavin, a vitamin belonging to B-complex group, has been found in retina and is essential for normal vision. It is suggested that during twilight it transforms light of short wavelength into light of wave frequency to which the eye is sensitive. It also helps utilize vitamin A.

The first sign of riboflavin deficiency is corneal vascularization. Later, there is superficial and interstitial infiltration of cornea. Finally, congestion of sclera and iris occurs. The subject suffers from itching and burning of the eye, roughness, photophobia and impairment of visual acuity. The oxygen consumption of cornea is lowered, but that of corneal stroma is elevated. The corneal vascularity due to riboflavin deficiency always occurs in the entire circumference of cornea and this helps in correct diagnosis. Invasion of cornea by blood vessels occurs in several pathologic conditions. In 'rosacea keratitis', riboflavin administration may or may not help. "Eczematous kerato-conjunctivitis" is a manifestation of riboflavin deficiency. Patients suffering from it make a dramatic recovery with riboflavin. Another disease characterized by corneal vascularization is trachoma. This condition, again, may lead to complete corneal vascularization due to riboflavin deficiency in later stages and the patient is benefitted by riboflavin administration. In experimental animals, deficiencies of other nutrients such as zinc, sodium and amino acids cause corneal vascularization, but it is rare in man.

### Ascorbic acid (vit. C)

Ascorbic acid mediates oxygen uptake of the lens alongwith glutathione and cystine. It is present in crystalline lens and the surrounding fluid and is brought to the lens by blood circulation. Alternatively, it is also synthesized by the lens itself. In pathological states, the respiratory processes of the eye is affected and ascorbic acid metabolism is altered. With aging, the concentration of vitamin C in the lens decreases as compared to cortex.

**Prevention**

Like all other diseases, blindness due to vitamin A deficiency is preventable and can be reversed in earlier stages. Green leafy vegetables are a very rich yet inexpensive source of carotene. Other orange-yellow vegetables, fruits like mango and papaya, milk, egg, etc., are also good sources. Vitamin A is so widely distributed in nature that choosing a judicious diet providing enough vitamin A is an easy task. Adult requirement of vitamin A is about 750 micrograms per day, whereas children require about 250-400 micrograms per day. Government is running a prophylaxis programme of vitamin A supplementation through family planning centres for preschool children. Under this program children are given massive dosage of vitamin A—200,000 IU, once in 6 months.

The diet should therefore include a variety of food stuff such as mixture of cereals, pulses, plenty of fruits and vegetables to ensure enough B-complex and ascorbic acid. Consumption of whole grain flour instead of refined flour (unsieved flour), sprouted legumes, raw vegetables, etc., make a diet more nutritious without increasing the cost. A daily supply of B-complex and vitamin C is essential as they are water-soluble and are not stored in the body. Animal proteins possess highest biological value among foods hence their inclusion in the diet is advisable.

JAMUNA RANI RAO
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# All about breasts

BREASTS are glands located in the anterior part of thorax and extend from the second to sixth rib. The breast opens outside through a nipple which is at the level of 4th intercostal space and is surrounded by a circular pigmented area called areola.

Each gland consists of sixteen to twenty lobes. Each lobe has its own system of alveoli, ducts, etc., which opens to the outside at the nipple. The lobes are separated from each other by connective and fatty tissues. These tissues along with suspensory ligaments—another form of connective tissue—provide support to the breast.

The ducts branch all through breast tissue and finally terminate in sac-like structures called alveoli. The alveoli are just like a bunch of grapes with stems equivalent to ducts. The alveoli are lined by a single layer of epithelium. They secrete milk and pour it into the lumen.

During childhood, there is practically no difference between male and female breasts. However, at puberty, the female breasts begin to develop due to enlargement of the alveolar tissue and ducts and deposition of fat. This enlargement is evoked by female sex hormones—estrogen and progesterone. As a male child lacks the requisite quantities of estrogen and progesterone, his breast tissue does not develop. In addition to these hormones, other hormones like growth hormone and prolactin, both secreted by the pituitary gland, are also needed.

During pregnancy, the placenta secretes a number of hormones including estrogen and progesterone. Several of these hormones further stimulate development of the mammary glands so that the breasts during pregnancy become almost double their pre-pregnancy size. Uusually no milk is initiated during pregnancy. It is believed that high levels of progesterone during pregnancy make breast tissue refractory to the action of prolactin which is one of the most important hormones needed for initiation of lactation. However, with parturition and expulsion of placenta, levels of estrogen and progesterone decline Prolactin, in conjunction with other hormones, now acts on the breast tissue and milk production starts. During the early 2-3 days post-partum the gland secretes a few c.c. of fluid called colostrum which finally changes into milk. Continued secretion of milk is dependant upon frequent suckling. If the mother stops nursing her infant, milk secretion stops very rapidly. However, with continued nursing milk production can remain uninterrupted for years.

Although milk is secreted into the lumen of alveoli, the infant cannot get it unless it travels through ducts into the nipple area. This is accomplished with the help of a reflex action. The suckling infant stimulates receptors in the nipple or areola which send sensory impulses to the hypothalamic portion of the brain. The hypothalamus causes secretion of another hormone called oxytocin from the posterior pituitary gland. The oxytocin travels through blood and reaches mammary gland where it stimulates the contraction of specialized cells called myoepithelial cells. Since the latter cells surround the alveoli and ductules, their contraction forces milk to be ejected into the infant's mouth. This whole process from suckling to ejection of milk takes less than 45 seconds.

Since oxytocin also causes uterine

*(Continued on page 59)*

# Science in Industry

## Inhibitor for prevention of corrosion in cooling water system

THE Central Electrochemical Research Institute (CECRI), Karaikudi, has developed an inhibitor formulation which gives effective inhibition to a variety of metals used in cooling systems under wide variations in the composition of the cooling waters, which is not possible with the individual constituents. Presently available inhibitors either do not give satisfactory inhibition at high salt concentrations, or are not effective for copper and brass.

The CECRI process is very simple and consists in thoroughly mixing four different chemicals in solid form in a definite proportion.

The inhibitor system is on-toxic and has freedom from the risk of pitting corrosion.

The process has been developed on laboratory scale; 5 kg sample of the product has been prepared in the laboratory at a time.

The efficacy of the inhibitor has been put to several tests : (i) beaker test; (ii) flow test; (iii) test under rotation, and (iv) circulation test rig simulating practical heat exchanger conditions.

Sodium hexametaphosphate, borax, zinc sulphate and magnesium sulphate are the main raw materials required in the process. All the materials are available indigenously.

The items of equipment required are ball mill, Avery balance, and polythene drum.

The total investment required to set up a plant of 30 tonnes per annum capacity has been estimated at about Rs. 76,300, comprising a fixed capital on building of Rs. 4000; a fixed capital plant of about Rs. 22,500; and working capital of Rs. 49,800. The cost of production has been worked out as Rs. 6.30/kg.

The process (NRDC Process No. 825.10.9) is available through the National Research Development Corporation of India, New Delhi, 110024.

## Technology for small-scale sector

A simple and economically viable technology for small sector for coloration of glass has been developed by the Central Glass and Ceramic Research Institute (CGCRI), Calcutta. Principal colour shades can be introduced at the firing temperature range of 480 C-590°C.

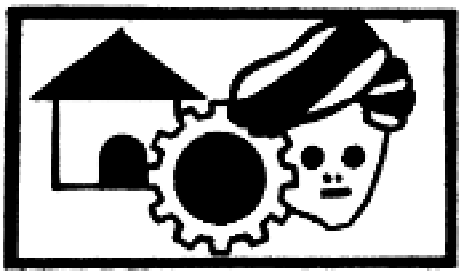
Pigments produced according to the process can be used for imparting coloration to table glassware, lighting fixtures, marking on bottles used for beverages and medicines as also in pottery and enamel industries.

Equipment and accessories and other raw materials required are simple and available within the country. Commercial feasibility of the process has been studied at the laboratory which has produced and supplied to industry glass colours worth Rs. 2 lakhs. The process would save considerable foreign exchange since substantial quantities of these pigments are still imported.

## Chemical additives for steel and petroleum industries

INDIA has become world's first country to successfully use a chemical additive for beneficiation of iron ore. The powerful additive has been developed by the Regional Research Laboratory, Jorhat. Its efficacy for beneficiation was established after thorough testing by the Research and Development division of the then Hindustan Steel Ltd., Steel Authority of India Ltd., the successor organisation, has started using the chemical for iron ore beneficiation. Manufacture of the additive has been commenced by an industrial concern licensed for the purpose.

The laboratory has also developed a chemical additive for pre-treatment of the crude oil before its transportation to refinery through pipelines. Pre-treatment improves the flow of crude otherwise hindered by high wax content. Current requirements of such additives are met through imports which cost the country Rs 2 crores per annum in foreign exchange. The demand would go upto Rs. 10 crores ultimately. RRL-developed additive has proved a success at all concentrations and doping temperatures in field trials by prospective users.



# TECHNOLOGY FOR VILLAGES

## Agro–technology

INDIA is basically an agricultural country and agriculture accounts for about 50 per cent of GNP and provides occupation to about 80 per cent of the population. Rural development and prosperity, are closely linked to productivity and profitability in agriculture It has been established that development of agriculture is associated with adequate use of agro-chemicals at appropriate stage, use of modern agricultural implements and adoption of improved practices of cultivation. CSIR laboratories have made specific contributions towards development of technologies for manufacture of pesticides, cultivation equipment and investigations on agro-technologies for specific economic crops like aromatic and medicinal plants.

### Agro-chemicals

CSIR laboratories have a co-ordinated programme for the development of technologies for manufacture of wide range of pesticides, herbicides and plant growth regulators. The processes for nitrofen, nicotine sulphate, phenthoate, warfarin, lindane and citicide have been commercialised. Technologies for dalapon, simazine, atrazine and endosulfan have been released to industry. Besides, National Chemical Laboratory (NCL), Pune, has developed know-how for a number of important industrial chemicals of this group, e.g., tetradifon. maleic hydrazide, cycocel, fenitrothion, dimethoate, chlordane, ethion, vitavax, PCNB and ethephon. Regional Research Laboratory (RRL), Hydrabad has developed processes for manufacture of MBC, monocrotophos and methoxychlor for the sponsors. Processes for manufacture of quinalphos and phosphamidon have been developed at RRL, Jammu-Tawi. NCL has develpped a slow-release herbicide formulation for the control of Parthenium weed which is threatening agriculture and grazing land in many States in the country. Work is being done on pilot plant production for multilocational trials. Central Salt & Marine Chemicals Research Institute, (CSMCRI), Bhavanagar has developed processes to obtain potassium chemicals from mixed salt, which can be used as soil nutrients. The process for manufacture of potassium chloride has been worked out on pilot plant scale. Potassium schoenite, a double sulphate of potassium and magnesium is now being produced on commercial scale. A project has been undertaken by CSMCRI with a view to obtain liquid sea-weed fertiliser which has proved to increase crop yields and is also resistant to fungal infections. It can be used as a foliar spray or may be added to the soil.

### Agro-engineering

Central Mechanical Engg. Res. Institute, (CMERI), Durgapur successfully developed a 20 H. P. Tractor ideally suited to Indian conditions where land holdings are relatively smaller than those in the advanced countries. These tractors are being manufactured by Punjab Tractors Ltd., Chandigarh, a State owned enterprise. During 1976-77, nearly 3250 tractors were manufactured. The Institute is also working on the manufacture of low H.P. Tractors. CMERI has developed and released designs of many tractor-drawn implements such as spring tine cultivator, disc plough, disc harrow and jungle jim which are already available in the market. It has also developed ancillary implements like soil cutter, soil mixer, harvester and potato digger. Rotiller, a dual purpose machine, developed jointly by Central Road Research Institute (CRRI), New Delhi and Mechanical Engg. Res. and Dev. Organisation (MERADO), Pune is useful both for agriculture and road making. These rotillers are being commercially manufactured in India. A portable hand operated continous knapsack sprayer has been developed by MERADO, Ludhiana.

Regional Research Laboratory, Bhubaneswar has developed hand operated bellow pump suitable for lifting water for irrigation and other purposes. It has also designed a handy tool for digging uniform holes manually for fixing poles, fencing, soil testing etc. Central Scientific Instruments Organisation's (CSIO) Universal Moisture Meter is useful for quick measurement of moisture content in food grains etc. The equipment is being commercially manufactured.

# BOOK REVIEWS

**EVER SINCE DARWIN** by Stephen Jay Gould, *Penguin Books*, *Avail-from* : M/s Penguin Overseas Ltd., 706-Eros Apt., 56-Nehru Place, New Delhi-110 024. Pp. 285, £ 1.50.

"ONE hundred years without Darwin are enough", was the remark of the noted American geneticist H.J. Muller in 1959, the centenary year of the publication of the *Origin of Species*. It struck many a listener as a singularly inauspicious way to greet the occasion, but no one could deny the truth expressed in its frustration. In fact, few other books have created such a lasting storm of controversy as the *Origin*. Darwin's theory of evolution based upon the notion of "survival of the fittest" stirred up public debate to a feverish pitch. Yet its acceptance revolutionised the course of science. In fact, the world has not been the same ever since Darwin.

But, why has Darwin been so hard to grasp? Within a decade he had convinced the thinking world that evolution had occurred, but his own theory of natural selection never achieved much popularity during his lifetime. It did not prevail until the 1940s, and even today, though it forms the core of our evolutionary theory, it is one of the most misunderstood, misquoted and misapplied. In the 30 and odd essays of the book under review, author Stephen Gould attempts to remove many of the misunderstandings and misapprehensions about Darwin's theory. In this task, I feel, he succeeds brilliantly.

The essays, written during the period 1974-77, originally appeared in *Natural History Magazine* and cover a wide range of diverse topics in botany, geology, palaentology and much else. But they all have a common thread running through them—Darwin's theory of evolution. The essays cover a fascinating range of subjects—the importance and relevance of Darwinism, the question of size in nature, the bizarre sex life of a mushroom fly, continental drift, race and intelligence, and even Freud and Velikovsky, to name a few.

In the last chapter, the author outlines the probable future of Darwinism—the prospects for its second century. "I predict the triumph of Darwinian pluralism" says the author. Natural selection, he feels, will turn out to be far more important than some molecular evolutionists imagine, but not omnipotent, as some sociobiologists seem to maintain.

Gould's scientific insight and literary flair make his writing a joy to read. And he has an uncanny ability to drive his point home—be it explaining giant antlers of the Irish Elk in terms of Darwin's theory, or exploding the Velikovsky myth about worlds in collision. In short, *Ever Since Darwin* is a brilliant anthology which, I feel, every book-lover would be proud to possess.

BIMAN BASU

**ICE AGES Solving the mystery** *by* John Imbrie and Katherine P. Imbrie *Macmillan*, London (Available from *Macmillan Co. of India*, 2/10, Ansari Road Daryaganj, New Delhi-110002) Pp. 229, Price not stated .

IN the early 19th century, scratched and faceted boulders, the size of multi-storeyed buildings of today, were found in many parts of the world. But it was only around the Jura mountains of Switzerland, which are covered with glaciers, that the first inklings of an Ice Age was felt among the peasants, woodcutters, mountaineers, etc., who used to frequent the mountains. At that time scientists believed in the Biblical theory that the boulders were the remnants of a flood that covered the land during the Noah's time. It was, however, the dynamic young Swiss Geologist Louis Agassiz who combined the available evidences and put forward the theory that the boulders were indeed the remnants of a receding layer of glacier, some tens of kilometers thick. The theory took some time to gain acceptance but when it did it raised a host of questions, and as answers were sought, new questions appeared. Even today some questions remain unanswered for the lack of adequate data.

Soon after it was accepted that an Ice Age had once overwhelmed the earth, it was found that it had not once occurred but innumerable times in the past. At about the same time changes in the levels of sea-shores found at many coastal places supported the occurrance of Ice Ages. What caused these Ice Ages was naturally the next question that occurred to many minds, both scientists and non-scientists, and there appeared a spate of theories trying to explain away the evidences. However, finally, in the beginning of the present century the astronomical theory first proposed by James Croll, a teashop-keeper-turned-scientist, and its subsequent mathematical explanation by the Yugoslavakian engineer Milan Milankovitch triumphed over the other contending theories. According to this theory, the path of earth around the sun, the distance between them and the tilt of earth's axis caused the Ice Age cycles on earth. Although the theory fell foul for some time after its acceptance, it is only in the recent times that the deep-sea cores have provided the evidence to vindicate it.

The book under review gives an uptodate account of where the question of Ice Age stands today. The data have also been extrapolated to give an idea of when the next Ice Age will occur on earth. Written by an expert in the field and his daughter, the entire subject of Ice Age has been presented in the book in a historical perspective, giving here and there the biographial sketches of the pioneers and their moments of inspiration, which makes the subject lively and inspiring. The book is also replete with the problems, theories, controversies that scientists of the past faced in their search for an all embracing theory of Ice Ages that could explain all the geological, glacier and fossil records. The scientists no doubt appear as Sherlock Holmes and their adventures, as protrayed in the book, no less exciting than those of that fictional-master sleuth. Well illustrated and produced, the book would be enjoyed both by the laymen and experts. The publisher should, however, publish its paperback edition to bring it within the reach of a common man.

DILIP M. SALWI

**CHROMATOGRAPHY OF POLYMERS, PETROLEUM AND PETROCHEMICALS** Ed. *by* Sukumar Maiti, Symposium Director, Material Science Centre, Indian Institute of Technology, Kharagpur, Pp 374 + Index.

CHROMATOGRAPHY is proving to be of great importance to workers involved in fundamental and applied researches as it provides a quick and precise method for the analysis of chemical substances. Although several texts and monographs are available but most of them generally discuss the subject matter in details covering a broad spectrum.

The book under review is an outcome of a three day symposium and workshop on chromatography and its applications to polymers, petroleum and petrochemicals. It is a collection of articles by experts and contains chapters on fundamentals and applications of chromatography. The book has been written in a way that workers with informal training in organic physical chemistry and elementary calculus may understand the subject well. No prior knowledge of chromatography is assumed.

The first two chapters are devoted to basic principles of the technique. Next four chapters are concerned with the application of gas chromatography in petroleum industry. Individual chapters on the use of gas chromatography in the fertilizer, coal and polymer industries are given. The book also contains chapters on liquid chromatography, its fundamentals and applications in characterization of macromolecules. A chapter on the use of thin layer and column chromatography in the analysis of petrochemicals and pharmaceuticals has been added in the end.

The book represents a well-documented overall review of the advances in the field of chromatographic analysis of polymers, petroleum and its products. However, like many other books on a subject with contributory chapters by individual authors, the present book also suffers from repetition at different stages. However, every chapter is written so independently that the reader is not required to go through the whole book; the chapter of his interest may serve the purpose. Also, simple English has been used throughout the text.

The book in its present form will be of much interest to the scientists and technologists involved in the routine work or researches on application of chromatography to polymer and petrochemistry.

P. BAHADUR

**AN INTRODUCTION TO OPERATIONAL AMPLIFIERS** *by* S. V. Subrahmanyam, *The Macmillan Company of India, Ltd.*, 2/10, Ansari Road, New Delhi-110002, Pp. 132, Rs. 12.00.

THE book is written with a view to introduce the students to some aspects of operational amplifiers which after the advent of the integrated circuits are becoming basic components in electrical instrumentation, computation and control.

The book contains seven well written chapters. The first and second chapters deal with the fundamentals and analysis of the operational amplifiers respectively. The third chapter is devoted to the frequency response and stability while in the fourth chapter some aspects of the drift and chopper stabilization are discussed Next two chapters deal with some of the applications like mathematical operations, addition, subtraction, multiplication, differentiation and integration, waveform generators In the last chapter the theory of the active filters is developed in some details. At the end of most chapters questions, problems and experiments are included.

The book is well written. The material presented, although brief, is informative and provides necessary insight into the theory and working of the operational amplifiers One of the interesting aspect is the inclusion of experiments after some chapters. This will help familiarise readers with working of operational amplifiers. In Chapter 1 the author should have mentioned separately basic features of operational amplifiers and in the last chapter active filter characteristics should have found more space. Although problems are included in some chapters their answers are not provided. In absence of answers a reader cannot check the correctness of his solutions. The references should have been given chapter-wise. This helps to fish out the appropriate literature without trouble.

A. K. BHARGAVA

**HEAT AND THERMODYNAMICS** *by* D. S. Mathur, *Sultan Chand and Sons*, 23, Darya Ganj, New Delhi-110002, 3rd edition (1978) Pp., 671+xii, Rs. 20.00.

EVER since the observations of Count Rumford on generation of heat while boring the cannon of a gun and subsequent enunciation of laws governing the transfer of energy between macroscopic systems, the scope of thermodynamics has been continuously increasing. Today it covers wide areas of science and engineering—from combustion to nuclear and plasma engineering. As such, heat and thermodynamics forms an essential part of the syllabi of any undergraduate level science or engineering course. Many authors, both foreign and Indian, have written books on this subject. Most of the Indian authors have written their books keeping in view the syllabi of some particular universities. In view of the introduction of the new 10+2+3 pattern of education, undergraduate courses are being revised and there is an enthusiasm in 'established' authors to update their books and incorporate changes, wherever possible. Unfortunately, contrary to the author's claim, no sincere effort has been made to improve the book under review over its earlier editions. But for criticism, there is nothing in the book which needs special mention.

The book is spread over 9 chapters which are conventionally planned. One appendix on 'SI' units is also given. Each chapter is followed by a few solved examples. Unsolved problems with answers and a few typical questions are given at the end of each chapter.

Subject exposition on the whole is far from satisfactory and there is much scope for improvement. Without exception, the discussion is elementary and lacks rigour. To quote an example, in chapter 5, Maxwell's original proof has been given to arrive at the distribution law of velocities. This derivation is based on some heuristic assumptions which have little physical justification. To add, the author has not even cared to mention these inherent defects. One also gets the same impression from the discussion of transport phenomena. Similarly, in chapter 9 much is desired so far as the discussion on 'Radiation' is concerned. If the author wishes to make his book useful even for general course students 'approximate' derivations would not serve the purpose.

Last but not the least, the book contains some conceptual errors. One gets a very poor impression when one finds that the title page diagram—energy distribution curve for a black body radiation is one such lapse. This clearly reflects negligence on the part of the author. A more careful proof reading is required in future editions.

As such, the book can be of no use to any section of students.

SURESH GARG

**DIAGNOSTIC TESTING IN ADVANCED CHEMISTRY** *by* A. Brookes & W.A.H. Scott, *Hodder & Stoughton*, London (Available from : *B.I Publication*, 359, Dr. D. N. Road, Bombay-400001) Pp. 177, £ 1.80.

BOOKS based on objective type questions appear time to time since the examination pattern in science subjects has changed from conventional long and descriptive questions to quick objective tests. Chemistry is no exception. However, the relative number of books on this subject is less than those in physics, biology, etc. The book under review is a welcome addition.

The authors have tried to compile questions from almost every branch of chemistry—general and physical, organic and inorganic in a small book. Only most important problems from each topic are described, and there still remains various aspects for a detailed study of the subject.

The book has two advantages over many other objective type books on the subject. Firstly, of the four possible answers given for each problems, the incorrect three answers provide some useful information and have relevance to the problem. Secondly, not only the correct answers are given at the end of the chapter but the proper justification of their correctness based on some rule or law is also provided, which is rarely found in such books. Recent systems of unit and nomenclature are used throughout the book.

The book has a nice get-up and contains least number of mistakes—printing, grammatical or conceptual. It may be useful for chemistry students at University level. The book would be useful to those preparing for competitive examinations and those wishing to test their I.Q. after they have learnt the subject.

P. BAHADUR

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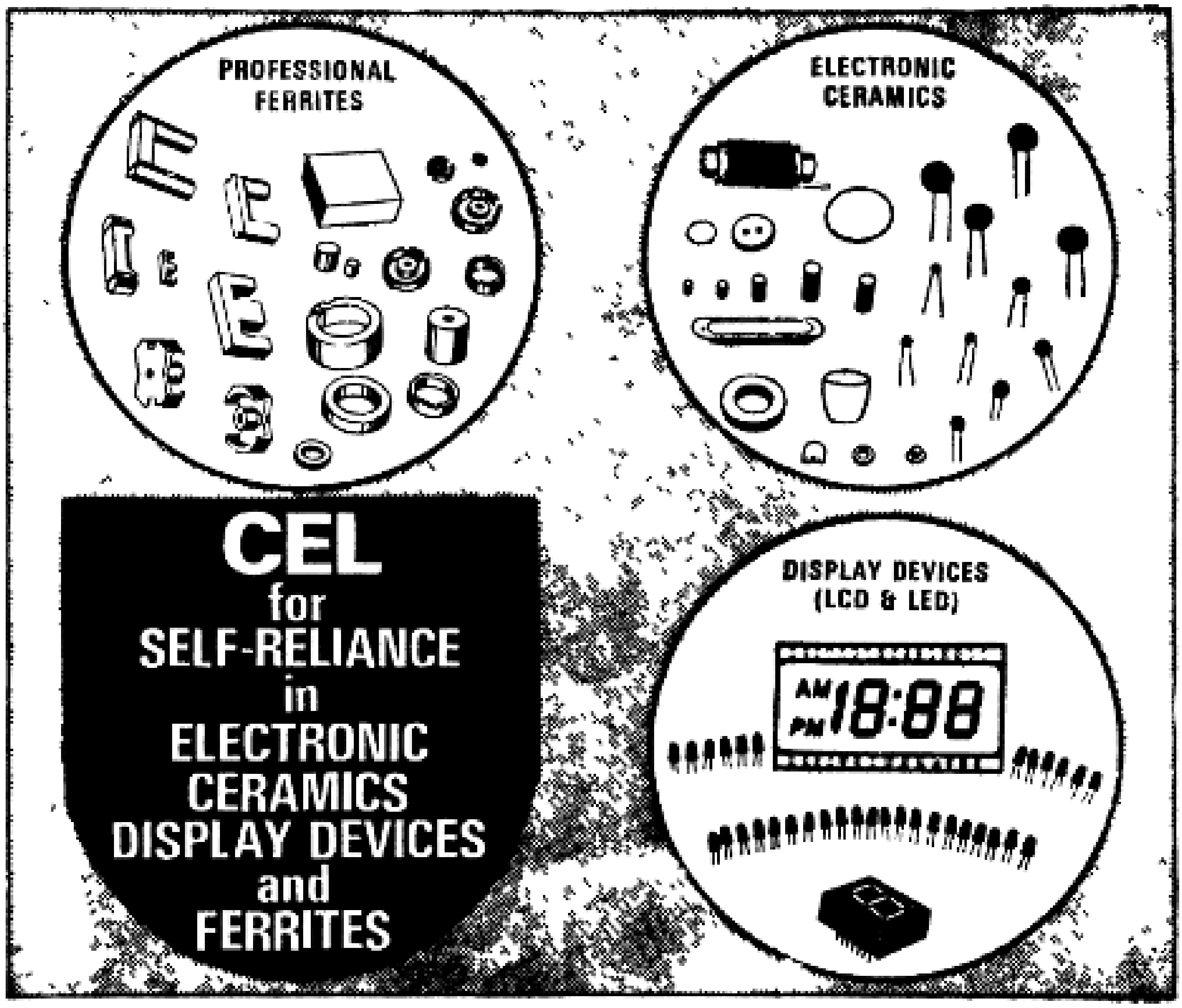
## Books Recieved

1. **HUMAN & SOCIAL BIOLOGY** (An objective type book), *by* L. Fairclough, *Hodder & Stoughton*, (Available from : *B. I. Publications*, 359, Dr. D. N. Road, Bombay-400023) Pp. 121, £ 1.85.
2. **ESSENTIAL IDEAS IN ORGANIC CHEMISTRY** *by* D. E. Wilson, *Hodder & Stoughton*, (Available from : *B. I. Publications*, address as above), Pp. 199, £ 2.95.
3. **MODERN MANAGEMENT** *by* Dick Carlson, *Jaico*, 125, Mahatma Gandhi Road, Fort, Bombay-400023, Pp. 183, Rs. 22.00.
4. **HOW TO CUT OFFICE COSTS** *by* H. H. Longman, *Jaico* (address as above), Pp. 300, Rs. 30.00
5. **HOW TO FIGHT DIRTY AGAINST MANAGEMENT** *by* Joe Mancuso, *Jaico* (address as above), Pp. 221, Rs. 25.00



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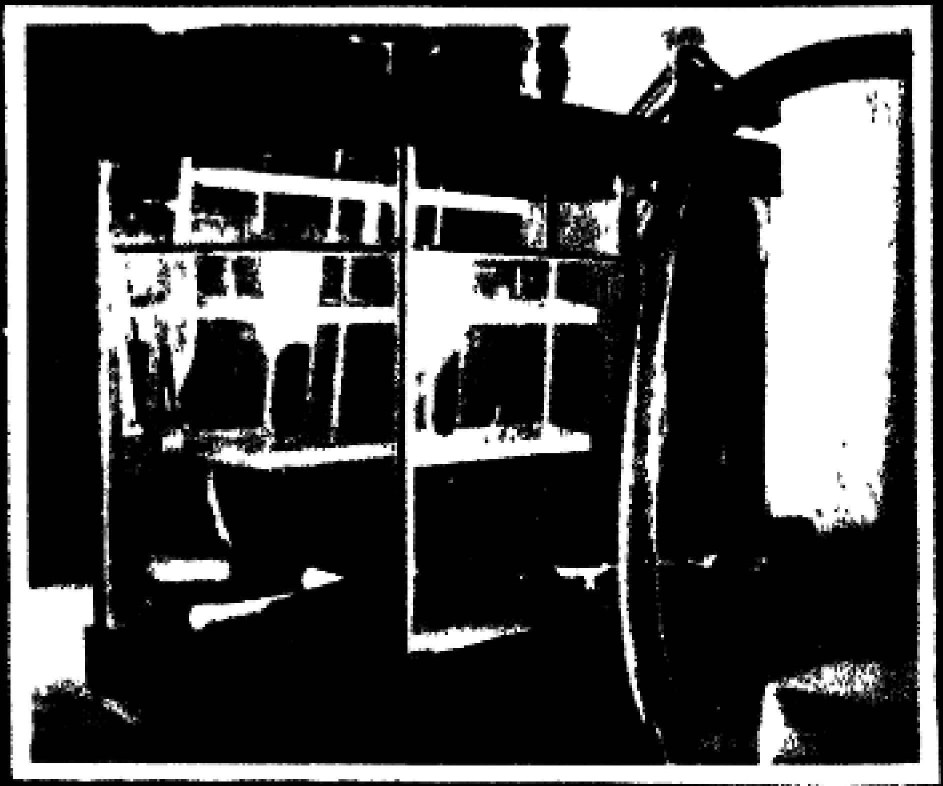

# HOW CHLOROPLASTS SYNTHESISE ATP

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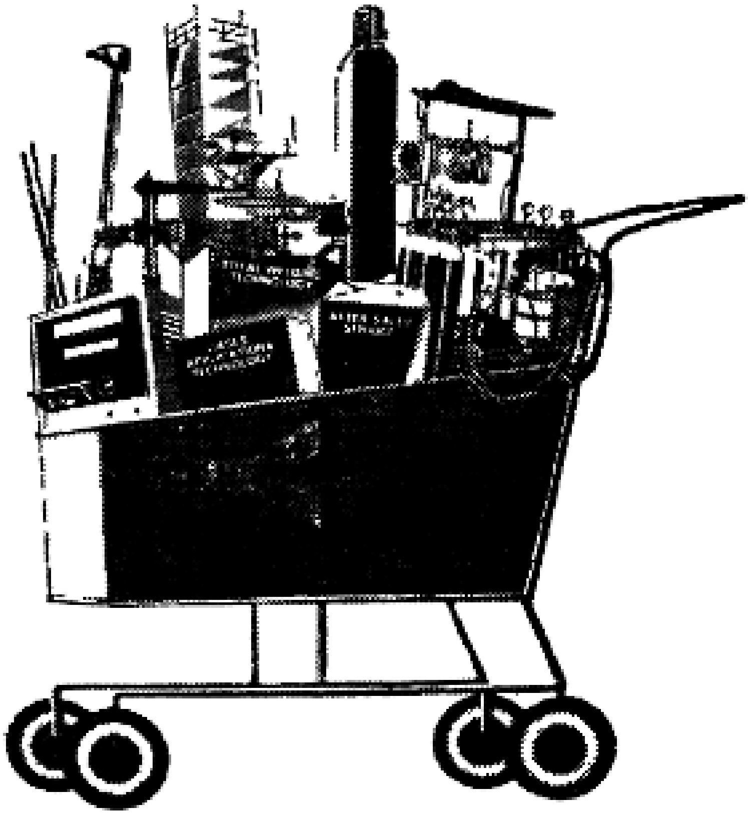

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# SCIENCE REPORTER

VOL. 17 OCTOBER 1980 NO. 10

*Cover : (Inset)* **Photosynthetic ATP formation measured in chloroplast suspensions (in test tubes) in an illuminated temperature-controlled waterbath**

632 LETTERS
635 PLANETS AND THEIR POSITIONS—NOVEMBER 1980

MAIN ARTICLES

636 **How choroplasts synthesise ATP** — *Jinesh C. Jain & Arnost Horak*
640 **Infrared photography and its applications** — *M. K. Sharma*
646 **Industrial catalysts and their mechanism** — *N. C. Dutta*
652 **Basics of instrumentations** — *S. N. Ghosh*
656 **The Balmer series of atomic hydrogen** — *R. C. Bhatt*
659 SCIENCE SPECTRUM
Did Venus evolve like earth?—Have quarks been found?—Solitons-mysterious particles of nature—Polymer lubricants—Sexual incompatibility in higher plants—Nickel—an essential trace element—H-Y antigen genes location—Synthesising common bread wheat varieties——Plant protoplasts culture—a new dimension in plant research—Why does *boro* rice require longer duration for maturity—Peach—a common fruit of the hills
674 NEWS AND NOTES
Meeting on Plan Frame for Science & Technology 1980-1985—S. S. Bhatnagar Awards-I
678 MEDICAL NOTES
Animal diseases and society
680 SCIENCE FOR THE YOUNG
William Harvey (1578-1657)—Brain teasers—Sponge (Poem)—Zoology quiz
684 FOR HER
Getting the most out of potatoes and tapioca—How to remove birth marks
686 SCIENCE IN INDUSTRY
NCL process on dimethylaniline—Carbon refractories
687 TECHNOLOGY FOR VILLAGES
Uses of tissue culture technologies—Medicinal and aromatic plants
689 BOOK REVIEWS
The Cosmic Connection—The Inner Limits of Mankind—Biological Applications of Solar Energy—Advanced Level Mathematics—Organization in Plants—Plus Two Practical Physics

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# LETTERS

## Abortion-inducing pheromones

Sir, In **Chemical communication in tiger** (*S.R.*, Feb. 1979), R. L. Brahmachary writes about a strange male pheromone that induces abortion in pregnant mice (p. 93). I would, however, like to add some recent information about this abortificient pheramone and potential significance of a comparable pheromone in the control of human fertility.

Hilde M. Bruce of Cambridge University, England, reported this physiological effect (*Nature*, **184**, 105, 1959) which is now called as Bruce effect. Her subsequent studies proved that this pheromone is secreted in urine (*Science*, **134**, 1049, 1961) and its production is under permanent control of androgens (*J. Reprod. Fert.*, **10**, 138, 1965). Thomas L. Avery of the St. Jude Children's Hospital, Tennessee, U.S.A., demonstrated that the termination of pregnancy after exposure of the female to the strange male urine is due to an alteration in gonadotrophins release from the anterior pituitary (*Science*, **164**, 423, 1969).

Chemistry of this mysterious pheromone, however, had received considerable attention of workers, but reports on it are still fragmentary. Recently, A.M. Koj and coworkers of the Jagiellonian University, Poland, suggested it to be a protein or a component bounded with protein which is associated with bladder, excreted urine and to the homogenates of the preputial glands. They investigated that this pheromone is present in urine of all males but its concentration, which varies in different strains, is of physiological significance. On this study, they explained why a strange male (which has a higher concentration of the pheromone) can induce Bruce effect and the stud males (of Inbred strain) cannot. They further demonstrated that besides Bruce effect, this biologically active substance also accelerates puberty (*Biol. Reprod.*, **17**, 729, 1977) in baby females (Vendenbergh effect) and modifies (shortens and synchronizes) the oestrous cycles (*Folia Biol. Reprod.*, **20**, 311, 1978) of mature female mice (Whitten effect).

It is now well-known that humans also employ pheromones for their communication (*S.R.*, Jan. 1977, p. 43; *Nature*, **260**, 521, 1976, etc.) Martha K. McClinktock of Harvard University, U.S.A., reported that pheromones also influence reproductive physiology of women (*Nature*, **229**, 244, 1971).

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## Gregor Mendel, the geneticist (1822-1884)

Sir, I have read with profound interest **Gregor Mendel, the geneticist (1822-1884)** by D. S. Virk and V.P. Gupta (*S.R.*, May 1980). Though the article gives an account of Mendel's life and his struggle for scientific accomplishment, it does not give the reasons for his success in discovering the principles of genetics or those for his failure in getting the work recognized during his life-time. I wish to mention these facts for the interest of the readers.

Mendel recognized the importance of using simple and unchanging characters in systems that can be completely controlled by the experimenter He had the insight to establish a set of criteria for experimentation that to this day must be met in genetic studies if meaningful results are to be obtained. Another reason for his success was that heredity is a quantitative science, involving accumulation of data, which must be sorted out and only a man with Mendel's mathematical training would recognize certain trends in the data. Finally his fortuitous choice of traits for study. As is the case in many monumental scientific discoveries, luck was on Mendel's side. This certainly does not demean the enormity of his accomplishment, as it still requires a great mind to capitalize on such opportunities. It was the painstaking application of these criteria which led to the formulation of Mendelian laws of genetics and earned for the brilliant, but unassuming, man the sobriquet "Father of Genetics".

There are several explanations for the sad neglect of Mendel's work. His first paper was published in the *Proceedings* of the Brünn Natural History Society, an obscure publication of limited circulation Furthermore, the paper was prepared as a lecture rather than a scientific publication. The raw data were not included and therefore the crosses could not be followed in detail. Mendel did not mention how he arrived at the idea from which the hypotheses were developed. Another view is that the time was not ripe, i.e., the biological world had not yet been brought upto the level where precise and mathematical work done by Mendel could appear promising.

Among other circumstances, at the time of Mendel's works interest of biologists centred on evolution and natural selection following the publication of *Origin of Species* by Charles Darwin. Finally, it has been suggested that Mendel might have won the recognition for his idea had he "advertised" it, and the reason why he did not do so was possibly the erratic numerical results with *Hieracium*. Mendel knew nothing about the parthenogenetic nature of this plant and was at a loss for an explanation. Towards the later stages of his life, Mendel himself did not believe that he had hit upon a general law, hence he did not strive for its recognition. Perhaps his innate modesty forced him to take such a decision.

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*Central Potato Research Station*
*Kufri, Simla-171012*

### Menstrual disorders

Sir, This is in regard to **Menstruation—mechanism and disorders** (*S.R.*, June 1980) by K.C. Kanwar. While conducting experiments on hostel girls, Martha K. McClinktock observed a marked suppression and synchronization (coincidence) in their menstrual cycles when they lived together in a dormitory and were not permitted to see a male (*Nature*, **229**, **244**, 1971). McClinktock remarked that girls who came frequently in contact with men often had regular cycles. Interestingly, a girl who had lengthy menstrual cycles of about 6 months (=180 days) returned to the normal state when she started dating with her boy friends. These studies show that, besides the factors described in the article (pp. 417-418), presence of males also has a great influence on menstrual cycles of women.

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### Indian names of constellations

Sir, C. Prathapa Reddy in his letter (*S.R.*, May 1980) has given a list of equivalent Indian names of the constellations. Prima facie his effort appears laudable since it is believed that early Indian astronomers, unlike the Greeks, were not interested in northern and southern constellations. However, in the list a good number of cases are merely translations of the Greco-Roman names. Furthermore, constellations introduced much later have been likewise provided an Indian garb. These facts cast aspersions on the originality and the antiquity of names of the constellations. Probably, Reddy has been swayed more by patriotic fervour than by rational thought. This field requires extensive research and not half-hearted approach which is bound to do more harm than good.

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#### II

Sir, I read with much interest letter of C. Prathapa Reddy (*S.R.*, May 1980). One may agree with him, only with reservations, when he says that our ancients did not leave any field or subject incomplete in any aspect. It will be a tall claim to say that our ancients had named most of the non-equatorial constellations. No doubt the list of names given by Reddy makes an interesting reading but one must not forget the fact that the Indian names given are mostly just translations of the Latin names. It is pertinent to point out here that king Jaisimha of Jaipur, a noted scholar and astronomer, attempted such a translation in the 18th century.

But the question is whether our ancients had made any attempts to identify these non-equatorial constellations and name them in the past, the proof of which must naturaally be culled out from our ancient *Siddhantas* or other texts wherein the employment of such names or descriptions of such constellations could be traced.

Fortunately, this study has engaged the attention of many a scholar in the past. It has been held that it would be a difficult task to assign appropriate Indian names to many of the non-equatorial constellations. The *Siddhantas* give the names of only a few stars and constellations, mostly of the ecliptic. For some of the other stars, we can associate them with fables from old scriptures and other ancient texts. It is evident, therefore, that our ancients have not catalogued all the non-equatorial constellations.

The names of constellations given by Reddy cannot be located in ancient texts. For example, Ursa Major is translated as "Bruhad Ruksha" to mean Great Bear. This constellation is better known as Saptarishi Mandala of yore. Rig Vedic references to "Pitarah" (The Fathers), "Sapta Mayuryyah" (The Seven Pea-hens), "Rikshah" (The Bear), etc., are associated with it. The *Brahma Siddhanta* gives the positions occupied by each of the seven 'rishis' and even 'Arundhati' which is Alcor —80 Ursae Majoris. Alcor makes a visual double with Mizar—Zeta Ursae Majoris, known to our ancients as 'Vasishta's Arundhati' taken as Vasishta's consort served as a test star for our ancients. Even now, it is customary in Hindu marriages that the bridegroom shows Arundhati to the bride on the marriage night. In favourable conditions, if one is unable to see Arundhati (Alcor) with naked eyes, it is time for him to consult an ophthalmologist.

Orion has played the most important part in legendary tales of the East and the West. Be it Orion falling in love with Merope or Prajapathi casting his lustful eyes on Rohit (Rohini), legendary heroes are seen given appropriate positions in the sky. Or could it be the other way about ? —a scheme to learn and remember the details of the starry heavens.

Orion termed as "Kalapurusha" in the astrological texts is referred to as Prajapathi or Mriga, Canis Major as Mriga Vyadha (The Hunter) and star Sirius as Lubdhaka. The southern pole is referred to as Yama Dhruva. Even the constellation Crux identified and named by A. Boyer only in 1679 was known to the Hindus long ago as Trisanku Mandala.

I desist from further elaboration for want of space, though more instances could be cited. But it is a fact that cannot be denied, as mentioned in *S.R.*, November 1979, that the main interest of our ancients was largely on the stars and constellations lying near and around the ecliptic. Though our ancients were even aware of some of the non-equatorial constellations (known and identified very late by others) and had made special studies of them, they have not left complete data on all non-equatorial constellations as they have done for the rest.

V S.K RAMAN
*Superintendent*
*Postal Stamp Depot*
*Madras-600004*

## The common lizard

Sir, Useful information has been furnished about the common lizard, *Calotes versicolor* by Shekar Dattatri (*S.R.*, Oct. 1979). He says that the female lays a clutch of 10-20 eggs, 15 to 20 days after mating. I have worked on the reproductive biology of this lizard and observed that mating occurs from May to August and oviposition takes place from July to early October in the normal course (leaving the extremities apart). Thus, after mating (fertilization), eggs are lodged in the oviducts for a period of 40 to 45 days and by the time they are laid, the embryo has already undergone considerable development.

Considering even the extremities, I have observed the earliest mating during late April and the earliest oviposition by mid-June at one extreme, and the latest mating upto the end of September and the latest oviposition upto early November, at the other extreme. At both the extremities the minimum time elapsed is about 45 days.

Both the onset and termination of reproduction are, to a large extent, governed by climatic conditions. The egg retention in oviducts for a period of at least 40 days holds good in spite of the fact that there exists geographical variations in the seasonal reproductive rhythms of the lizard, *C. versicolor*.

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*Karnakaka*

## Kelps

Sir, I read **The giant kelps** by K. N. Ramakrishnan (*S.R.*, May 1980) with much interest. While giving the economic importance of the kelps, the author has failed to give some of their more important uses. He says that only potash is extracted from kelps. Besides this element, iodine is also extracted in good amounts. The concentration of iodine in kelps may be as much as 20,000 times that of sea water.

Many species of kelps are used as food by man, especially in the Orient. In northern Europe and other parts of the world, they also serve as feed for farm animals. Kelp has long been used locally as a fertiliser. It has high nitrogen and potassium content but is low in phosphorus.

Extracts of kelp are important in a number of industrial processes. Probably 50 per cent of commercial ice cream is stabilized with algin, a colloid obtained from the cell walls of brown algae. Algin imparts a smooth consistancy to the frozen product and prevents formation of large ice crystals during storage. It is also used in the manufacture of pharmaceutical products, such as pills, ointments, dentifrices and in cosmetics, such as shaving creams and lotions.

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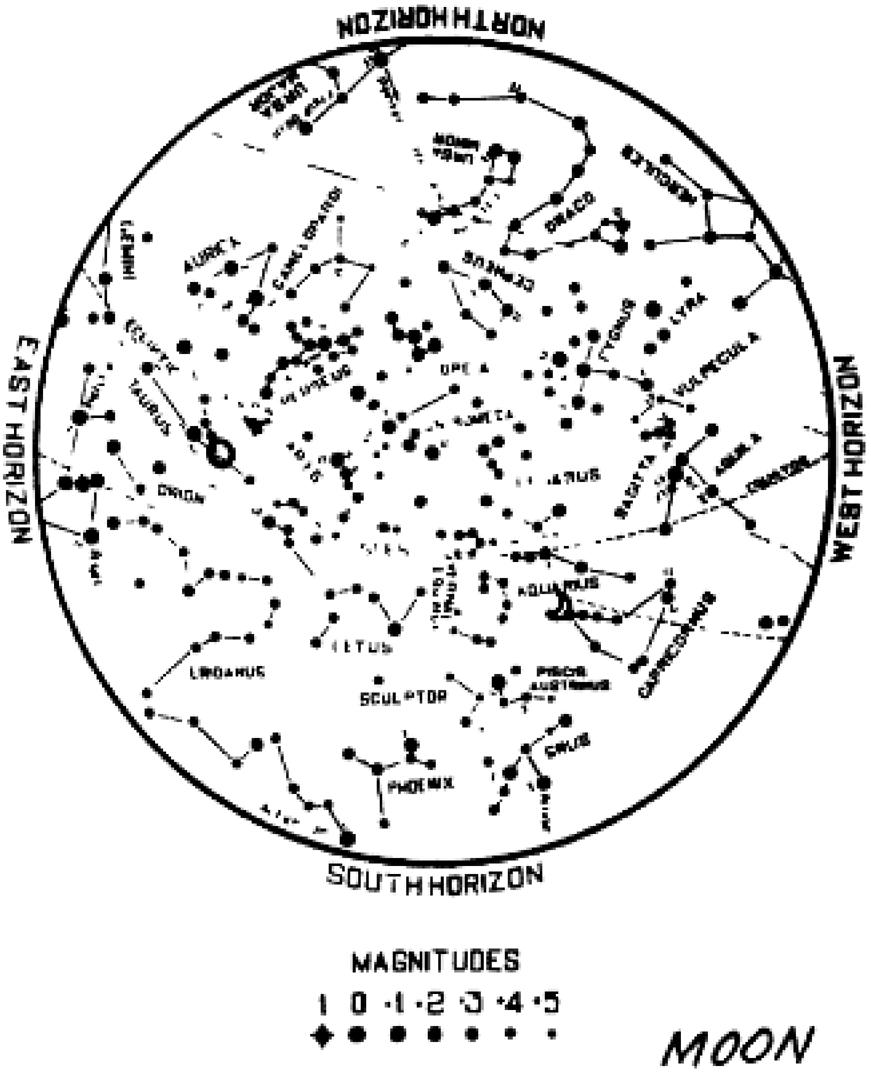
## Corrigenda

1. Ref *S.R.*, August 1980 (The DNA controversy), page 502, the correct legend for Fig. 2 is : Illustration of helix geometry showing a left handed double helix (a), and a right handed double helix (b).
2. Ref. *S.R.*, August 1980, (Science quiz), p. 554 *read* author's name as Vijay Deshpande.
3. Ref. *S.R.*, September 1980, page 598, *read* article title as 'Choral and its hydrate' *for* 'Chloral and its hydrates'.

# Planets and their positions

## NOVEMBER 1980



MOON

◐ FIRST QUARTER 15TH

O FULL MOON 22ND

### The moon

NEW moon is on 8th at 2-13 AM and full moon on 22nd at 12-09 PM IST. The moon passes about two and a half degrees north of Jupiter and two degrees north of Saturn and Venus on 4th and about five degrees north of Mars on 11th. The lunar crescent becomes first visible after the new moon day in the evening of 9th. The moon is at apogee or farthest from the earth on 5th and at perigee or nearest to it on 21st.

### The planets

**Mercury** (*Budha*) is too near the sun to be visible during the first-quarter of the month. It is in inferior conjunction with the sun on 3rd. Thereafter, it reappears as a morning star and rises about an hour before sunrise. It becomes direct on 12th. It is at the greatest western elongation of about 20° from the sun on 20th. It is in Libra (*Tula*). Its visual magnitude varies from +1.8 to —0.5.

**Venus** (*Sukra*), a morning star, rises about two and a half hours before sunrise during the month. It passes about half a degree south of Saturn on 4th. It also passes about 4° north of the star Spica (*Chitra*) on 17th. It moves from Virgo (*Kanya*) to Libra (*Tula*). Its visual magnitude is about —3.5.

**Mars** (*Mangala*), visible in the evening sky, sets about two hours after sunset during the month. It moves from Scorpio (*Vrischika*) to Sagittarius (*Dhanus*). Its visual magnitude is about +1.5.

**Jupiter** (*Brihaspati*), visible in the morning sky, rises about two and a half hours after local midnight during the first half of the month and about one and a half hours after it during the second half. It is in Virgo (Kanya). Its visual magnitude is about —1.4.

**Saturn** (*Sani*), visible in the morning sky, rises about three hours after local midnight during the first half of the month and two hours after it during the second half. It is in Virgo (*Kanya*). Its visual magnitude is about +1.2.

(*Source:* Director, Positional Astronomy Centre, India Meteorological Deptt., P-546, Block NC (1st Floor), New Alipore, Calcutta-700053).

# HOW CHLOROPLASTS SYNTHESISE ATP

JINESH C JAIN
ARNOST HORAK

**Light generates a proton gradient across the photosynthetic membrane; the flow of protons down this gradient provides energy for synthesis of ATP**

LIGHT propagates itself in a discontinuous or corpuscular manner, in the form of photons or quanta. The total amount of solar energy falling on the surface of the earth is estimated at about $10^{24}$ Cal/year Only 12 per cent of this energy is actually available to plant life, the rest is either outside of the visible range or is absorbed by the atmosphere or the non-living portions of the earth's surface Of all the ways in which life interacts with light, the most fundamental one is photosynthesis, the biological conversion of light energy into chemical energy As a matter of fact, all living things are ultimately dependent upon photosynthesis since it is the source of oxygen in the earth's atmosphere as well as the source of food for non-photosynthetic organisms.

During photosynthesis in higher plants, the inorganic gas $CO_2$ is reduced to the level of carbohydrates according to the equation

$$6CO_2 + 6H_2O + 686\ \text{Kcal/mol} \xrightarrow{\text{Light}} \underset{\text{Glucose}}{C_6H_{12}O_6} + 6O_2$$

The hydrogen needed for reduction of $CO_2$ is derived from $H_2O$ molecules The oxygen from the $H_2O$ molecules is not needed in photosynthesis and is therefore released as molecular $O_2$. The photosynthetic reduction of $CO_2$ to carbohydrates requires 686 Kcal of energy to form a mol. of glucose. This energy is provided by light.

### Localization of photosynthetic reactions in higher plants

Photosynthesis occurs in all green plant tissue in specialized plant cell organelles referred to as chloroplasts Chloroplasts (Fig 1) are lens-shaped organelles about 5 $\mu$ long and 2$\mu$-3$\mu$ wide ($1\mu = 10^{-6}$m) The chloroplast is surrounded by a double-membrane envelope which regulates the transport of metabolites into and out of it Stroma is the liquid, slightly granular, material filling the chloroplasts and containing the enzymes responsible for photosynthetic reduction of $CO_2$ to carbohydrates. Besides stroma, chloroplasts contain an extensive lamellar system. These lamellae, called thylakoids, form stacks called grana. Grana are connected together by individual stroma lamellae The lamellar system contains all the photosynthetic pigments of the plant. These pigments, chlorophylls and carotenoids, absorb light in the initial event of photosynthesis. The energy of these absorbed light quanta is used to photooxidize a molecule of $H_2O$ to molecular oxygen, protons and electrons. The electrons removed from $H_2O$ pass through a series of electron carrier compounds, that are also present in photosynthetic membranes until they reach the coenzyme $NADP^+$ (nicotinamide adenine dinucleotide phosphate) which they reduce to NADPH. This flow of electrons from $H_2O$ to $NADP^+$ is accompanied by photosynthetic formation of ATP (adenosine triphosphate) from ADP (adenosine diphosphate) and Pi (inorganic phosphate) This process is termed photophosphorylation. The resulting ATP is a molecule with a high content of chemical energy. Together with the NADPH formed as a result of photosynthetic electron transport, ATP is used to drive the energy-requiring reduction of $CO_2$ to carbohydrates.

### Mechanism of ATP synthesis

Since ATP formed during photophosphorylation is required for photosynthetic formation of carbohydrates, as well as for many other biosynthetic reactions that require an input of chemical energy, it is important to understand how ATP is formed during photophosphorylation and how this ATP synthesis is regulated in the plant. Although we know that the light-induced electron transport in the photosynthetic membranes provides

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Preparation of chloroplasts by differential centrifugation of leaf homogenates

the energy for ATP synthesis, the molecular mechanism of this ATP formation is not yet known.

The British biochemist Peter Mitchell, in 1961, was the first to realize that the buildup of protons in the thylakoid sac might serve as a source of energy to drive photophosphorylation. Phosphorylation of ADP to ATP calls for a source of energy and does not occur spontaneously. Mitchell suggested in his chemosomatic hypothesis that the flow of electrons from $H_2O$ to $NADP^+$ through the system of electron carrier molecules results in generation of protons on one side and consumption of protons on the other side of the thylakoid membrane. As a result, an electrochemical proton gradient is created across the membrane. The gradient consists of two components: a difference in hydrogen ion concentration (pH), and a difference in electric potential. The flow of protons down the gradient provides energy for the protein coupling factor ($CF_1$), an enzyme bound to the thylakoid membrane surface, to synthesize ATP.

The key predictions of Mitchell's hypothesis were confirmed by experiments in many laboratories. Among them was an experiment by Andre T. Jagendorf of Cornell University and Ernest G. Uribe of Washington State University showing that ATP could be synthesized in total darkness if a proton gradient was artificially created across the thylakoid membrane. How does the photosynthetic electron transport generate a proton gradient across the thylakoid membrane and how is this proton gradient used to drive ATP synthesis in chloroplasts ?

Let us consider the molecular events following light absorption in thylakoids in more detail (Fig. 2). Light supplies the energy required for removal of electrons from $H_2O$ and their transport through the electron carriers to $NADP^+$. Light is absorbed by photosynthetic pigments which are bound to proteins and are stationed at two points in the electron transfer chain. The green pigment chlorophyll is the central molecule of photosynthesis. Chlorophyll and accessory pigments such as betacarotene and xanthophyll absorb light over a large portion of the visible spectrum. This collection of light absorbing pigments, called the antenna complex, is embedded in the thylakoid membrane. The pigment molecules of the antenna complex absorb a light quantum and the energy of excitation is transferred from the antenna complex to a specialized chlorophyll molecule called P-680 (P stands for pigment and the number refers to the wavelength of light in nanometres that the molecule absorbs). The absorption of a single photon of light by a chlorophyll molecule gives rise to a separation of positive and negative charges in a special region of the membrane, containing P-680 and known as the reaction centre. P-680 which has lost an electron, has a positive charge, and the free electron, now the recipient of much of the energy of the absorbed photon, is transferred to an electron acceptor on the outer surface of the membrane. On the absorption of another photon the process is repeated. The two oxidized P-680 molecules are reduced by two electrons derived from water with the help of an enzyme that contains manganese The oxygen atom from the water molecule diffuses out of the chloroplast and the two protons go into solution on the inner side of the thylakoid membrane.

The two electrons that cross the membrane from P-680 are picked up at the outer surface of the thylakoid by a hydrogen carrier called plastoquinone or PQ. The electrons, and two protons coming from the stroma, reduce PQ to $PQH_2$. The reduced plastoquinone migrates back across the membrane to the inner surface. There the $PQH_2$ transfers the electrons to cytochrome f, and the pro-

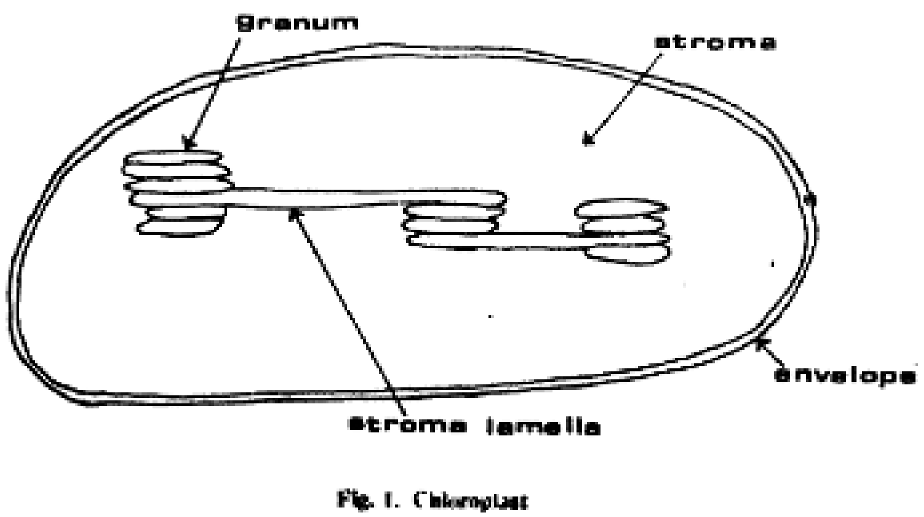


Fig. 1. Chloroplast

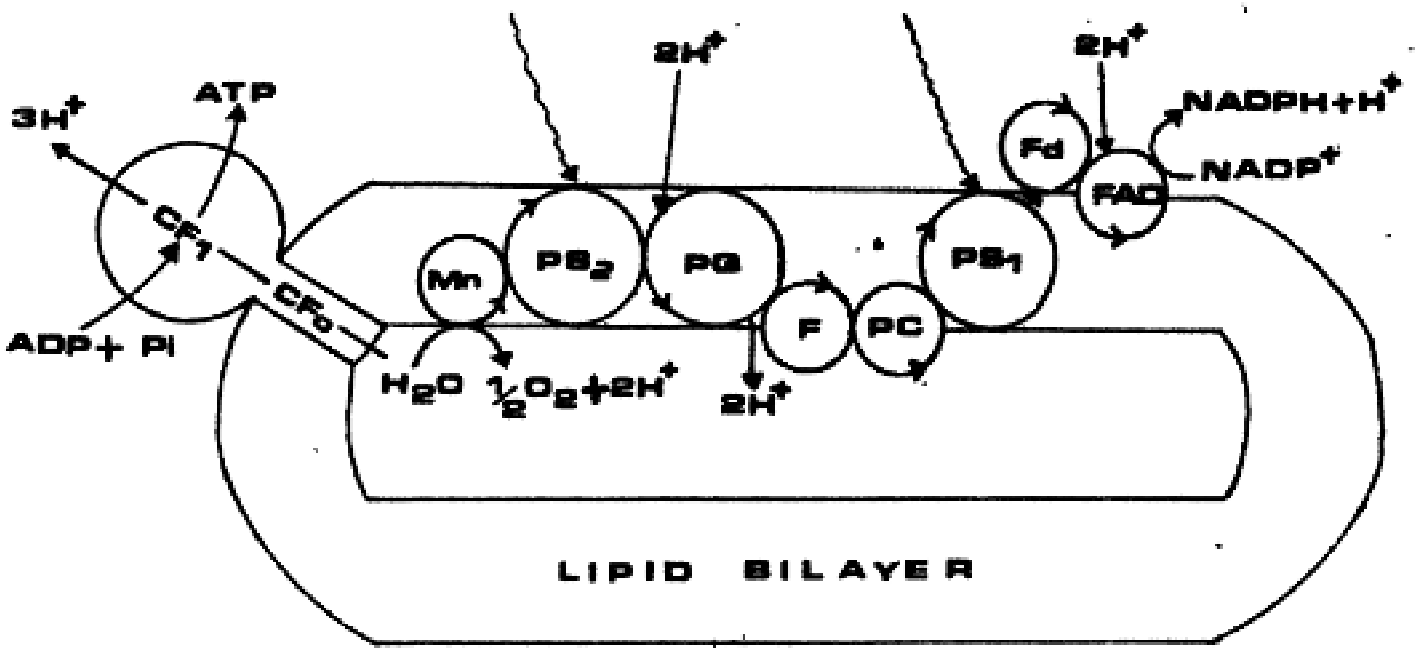


Fig. 2. PS$_1$ – Photosystem 1, PS$_2$ – Photosystem 2, CF$_0$ – Membrane portion of the coupling factor complex, CF$_1$ = Coupling factor 1, F = Cytochrome f, PQ – Plastoquinone, PC – Plastocyanin, Fd = Ferredoxin, FAD = Flavine Adenine Dinucleotide, Mn = Manganese

tons are released inside the thylakoid sac. From cytochrome f, the electrons flow to the copper-containing protein plastocyanin which transfers the electrons over to the second photochemically active site containing another specialized chlorophyll molecule, called P-700. P-700 is excited by light absorption and transfer of energy to it from the antenna complex. The electrons from the excited P-700 are accepted by an iron-sulfur protein at the outer surface of the membrane. There, the iron-sulfur protein reduces ferredoxin. From ferredoxin the electrons flow to a protein containing flavin adenine dinucleotide (FAD), which on reduction combines with two protons from the stroma to form FADH$_2$. In the last reaction of electron transport NADP$^+$ is reduced by the electrons and a proton from FADH$_2$ to form NADPH. As a result of the electron flow from H$_2$O to NADP$^+$ three protons are removed from the stroma-facing side of the membrane and four protons are generated inside the thylakoid sac.

The light-induced transfer of electrons is accompanied by an acidification of the internal space of the thylakoid sac. The hydrogen ions responsible for this acidification come from two sources: the protons released during the removal of electrons from water and the protons actually pumped across the thylakoid membrane in the course of electron transport. A large amount of free energy is stored in the proton gradient established by photochemical electron transport. Part of this energy can be recovered by allowing the protons to flow back across the thylakoid membrane through a membrane-bound enzyme catalyzing phosphorylation of ADP to ATP.

The enzyme system that couples the diffusion of protons back through the membrane to the synthesis of ATP is the CF$_1$-CF$_0$ complex, which is called the coupling factor complex. The CF$_1$ portion of the complex protrudes from the outer surface of the thylakoid membrane. Protons flow outward through the CF$_1$-CF$_0$ complex and the ATP is formed in the CF$_1$ portion. The evidence indicates that for every three protons passing outwards through the complex one molecule of ADP is combined with inorganic phosphate to form ATP.

The CF$_1$-CF$_0$ complex is composed of two multisubunit parts. One portion, designated coupling factor I (CF$_1$), appears to be peripheral to the membrane because it is easily and reversibly dissociated from the membrane without disruption of the lipid bilayer of the thylakoid membrane. It is composed of five different subunits. ATP-hydrolytic (ATPase) activity can be induced in the CF$_1$ solubilized from the membrane but, having lost connection to the proton gradient, it can no longer synthesize ATP. The remaining portion of the complex, designated CF$_0$, is apparently integral with the membrane and mediates proton translocation. Membranes partially depleted of CF$_1$ are devoid of ATP synthetic activity even if some CF$_1$ molecules with ATPase activity still remain attached to them because then the capacity to maintain a proton gradient is lost. The activity of photophosphorylation is restored if $CF_1$ molecules are added to the depleted membranes under appropriate conditions. One can conclude, therefore, that the $CF_1$ structure is required both to prevent dissipation of the proton gradient and to catalyze the production of ATP.

The mechanism of ATP synthesis at the active site, which is associated with the $CF_1$ part of the $CF_1$-$CF_0$ complex is not yet known, but it is under active investigation. It is well established that illuminated chloroplast membranes catalyze formation of γ-labelled ATP on incubation with ADP and $^{32}$Pi. Several hypotheses have been proposed to explain the molecular mechanism of photosynthetic ATP formation. All of them recognize the flow of protons through the $CF_1$-$CF_0$ complex as the driving force for ATP synthesis, but they differ in their views on how the protons are used for the ATP formation (either directly or indirectly). In a direct mechanism proposed by Mitchell, the protons flow through the $CF_0$ portion of the $CF_1$-$CF_0$ complex and attack one of the oxygens of the inorganic phosphate bound at the active site of the $CF_1$ portion of the $CF_1$-$CF_0$ complex. As a result, this oxygen is removed as a molecule of $H_2O$ and the remaining positively charged phosphorylium undergoes a nucleophilic attack by the negatively charged oxygen of the diphosphate side chain of ADP, resulting in formation of ATP. This ATP then dissociates from enzyme.

In the other mechanisms of photophosphorylation, such as those proposed by Paul D. Boyer of the University of California and by E.C. Slater of the University of Amsterdam, the role of the proton gradient is less direct. The proton gradient is assumed to cause conformational changes in the $CF_1$ portion of the $CF_1$-$CF_0$ complex. These conformational changes in the $CF_1$ protein in turn provide the energy to release ATP, formed earlier at the active site of $CF_1$ from ADP and Pi, into the solution.

Both, direct and indirect mechanisms discussed above assume that ADP is the phosphate acceptor during photophosphorylation. However, Roy and Moudrianakis of the Johns Hopkins University proposed a model for photophosphorylation in which AMP, rather than ADP, is the initial phosphate acceptor during photophosphorylation. According to these authors, the ADP formed from AMP and Pi is noncovalently bound to the $CF_1$ protein where it donates its β-phosphate to a molecule of substrate ADP to form substrate ATP and AMP, i.e., there is a transphosphorylation reaction (Fig 3).

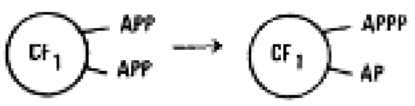


Fig. 3

One of the authors (A.H.) and Saul Zalik have used the ADP analog α,β-methylene adenosine 5′-diphosphate (AOPCP), in which the terminal phosphate is stable and does not split off, to test the proposal of Roy and Moudrianakis. Due to the stability of the terminal phosphate in OPCPA, this analog cannot undergo the transphosphorylation reaction required by their hypothesis. It was found that AOPCP can serve as a substrate for photophosphorylation. Recent experiments in our laboratory have shown that AOPCP competes with ADP for the ADP binding site on photosynthetic membranes. These results indicate that substrate ADP does not undergo a transphosphorylation reaction during photophosphorylation.

While no overall conclusion can be drawn at present about the details of the mechanism by which chloroplast manufactures ATP, it is clear that the chloroplast ATPase is a key enzyme in the photophosphorylation mechanism. This obviously requires further study. It is tempting to suggest that the chemical modifications of the active sites on the ATPase and interactions of nucleotides with nucleotide-free preparations of the enzyme may be helpful in probing the nature of these sites and therefore deciding a precise model for ATP synthesis.

**Further readings**

1. Lehninger, A.L. (Ed.), Photosynthetic electron transport and phosphorylation, *Biochemistry* (1975), Worth Publishing Inc.

2. Trebst, A., and M. Avron (Eds.), Photosynthetic electron transport and photophosphorylation, *Photosynthesis I* (1977), Springer-Verlag.

3. Boys, Paul. D., Chance, Britton-Ernster, Lars, Mitchell; Peter Racker Efraim and Slater, E.C. (1977), Oxidative phosphorylation and photophosphorylation, *Ann. Rev. Biochem.*, **46**, 955, 1026.

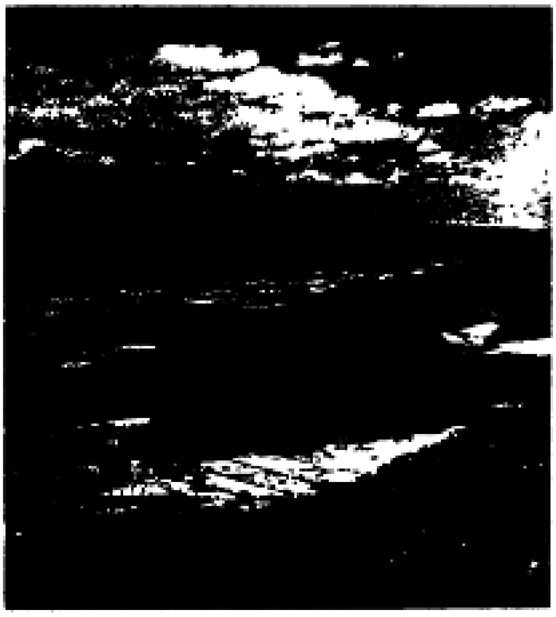
4. Harris, David (1978), The interactions of coupling ATPases with nucleotides, *Biochim. Biophys Acta*, **463**, 245-273.

5. McCarty, Richard C. (1979), Roles of a coupling factor for photophosphorylation in chloroplasts, *Ann. Rev. Plant Physiol.*, **30**, 79-104.

6. Baird, Barbara A. and Hammes, Gordon G. (1979), Structure of oxidative and photophosphorylation coupling factor complexes, *Biochim Biophys. Atya.*, **49**, 31-53.

**Infrared photography offers unique possibilities in a wide range of fields that encompass agriculture, resources survey, medical diagnosis, crime detection and even astronomy**

M. K. SHARMA



INFRARED photography is the recording of infrared images by photography. It offers aid in such fields as studying water pollution from the air, surveying timber resources, investigating the infrared luminescence of coals, determining a painter's methods, unmasking a burglar, revealing the text of an ancient scroll, exposing a forged document, or picturing the nocturnal flight of bats. Whatever the purpose, infrared photography provides information unobtainable by other means.

In 1800, Sir William Herschel, a German astronomer, discovered the infrared region of the solar spectrum. An illustration of the electromagnetic spectrum is shown in Fig. 1. Beyond the visible red, there extends a region of longer wavelengths in the neighbourhood of very short radio waves. These rays are invisible to eye but detectable by our sense of warmth and are known as heat waves or infrared, the latter meaning 'below red'. Infrared radiation can be classified into three broad ranges of increasingly longer wavelengths: near-infrared region (from approximately 0.7 $\mu$ to 1.5 $\mu$), intermediate or middle-infrared region (from approximately 1.5 $\mu$ to 5.6 $\mu$), and far infrared region (from approximately 5.6 $\mu$ to 1,000 $\mu$).

In 1910, Professor R. W. Wood of Johns Hopkins University, Baltimore, U.S.A., was the first to take infrared photograph of a landscape. The striking feature of this photograph was the reproduction of grass and trees as snow white and the sky as midnight black. In spite of Wood's success, the photographic profession showed little interest in the use of infrared radiations until 1924, when an American scientist W. H. Wright of the Lick Observatory, U.S.A., photographed the Sierra Nevada Mountains, some 217 km away, by means of the haze-penetrating infrared rays. Since then a great deal of research has been carried on in the study of infrared photography. Around 1960 a special type of multi-layer colour film was found useful in different fields of infrared colour photography.

Regular black and white infrared photography can be defined as the technique of using a camera lens to focus an infrared image on to a photographic film sensitized to infrared radiation to obtain a black and white negative record and subsequently a positive print. The characteristics of infrared films, infrared sources, cameras and filters which are required for infrared photography are discussed here.

## Infrared films

Though methods for sensitizing emulsions to infrared have been known since the latter part of the last century, it was not until 1931 that renewed research in this field began for making available photographic plates and films sensitive to infrared. Sensitivity to radiations beyond the visible red is accomplished by adding to the emulsion certain dyes belonging to

---

Dr Sharma is Senior Scientific Officer, Instruments Research and Development Establishment, Dehra Dun 248000 the cyanine group. Photographic films are now available which are sensitive to the "actinic" range of infrared or near-infrared region from 0.7 μ to 13.5 μ. However, by using special methods, it is possible to record the spectrum upto 2.0 μ.

Infrared-sensitive materials are available in sheets or cut films, plates and in various sizes for miniature and roll film cameras. Infrared high-speed films have proved to be quite valuable for photographing living subjects or for making records of action in the dark when it is not practical to provide a high level of illumination for exposures. Infrared movie film makes infrared motion-picture photography possible at rather low levels of illumination, or in the dark. With such film, infrared records can be made of operations such as photographic processing, materials manufacture or biological studies under dark-adaptation conditions which must be performed under special lighting conditions. The technique is also useful for surreptitious photography, when the subject must not know that he is being photographed, as in criminal or insurance investigations, psychological studies and audience reaction recording.

## Infrared sources

Photographic lights of all kinds have high emission in the infrared region of the spectrum. All incandescent sources of radiation emit considerable quantities of infrared. Tungsten filament lamps, carbon arc and flash lamps radiate considerable infrared. Photofloods, photoflash lamps and electronic flash lamps are excellent infrared sources. Although radiant heaters such as flat-iron and electric heaters emit sensible quantities of heat, they are of little use in infrared photography. Long exposures are needed to take infrared pictures with radiant heaters.

During summer approximately 52% of the total of the sun's energy reaching the earth at noon lies in the infrared range. At least one-third of this radiation lies in the wavelength band suitable for photography. The useful infrared for photographic purposes is about 8%, less in winter than in summer, indicating the need of somewhat longer exposures at that time. The blue sky reflects little infrared because wavelength of blue is smaller than infrared rays. The shadows on the earth get less reflected infrared rays with the result they are reproduced in tones of black with little details in the infrared print. This accounts for the contrast in the print.

**Fig. 1. The electromagnetic spectrum. Only those radiations possessing photographic properties are included**

## Cameras and filters

Any good camera used for ordinary photography can be employed for infrared photography with some precautions. Certain plate and film

**Fig. 2. Colour formation with infrared colour film**

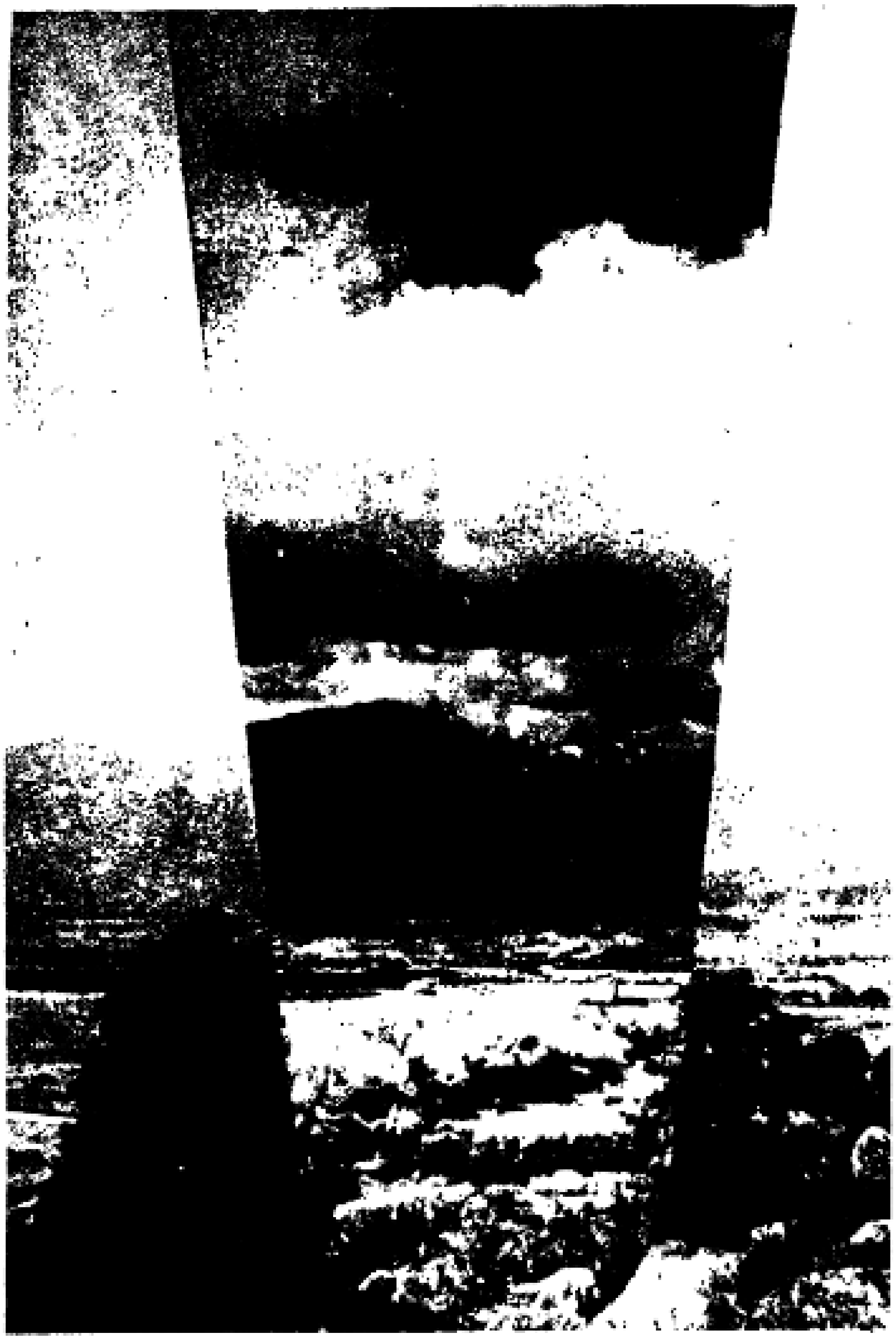


Fig. 3. A comparison of blue and infrared (central section) sensitivity of an infrared film

holders made of thin wood or composition materials, leather bellows, plastic lens boards and shutters and diaphragms made of materials other than metal, though opaque to visible light are fairly transparent to infrared. Should obscure streaks show up on negatives, it is a probable cause. All metal parts afford adequate protection to infrared films.

Most good camera lenses are suitable for infrared photography. Since infrared rays are longer in wavelength than visible light, they get focussed in a plane somewhat away from the plane at which visible light gets focussed. Some correction is usually necessary here. For shorter focal length cameras, the use of a small stop such as f: 11 or f: 16 may provide sufficient correction. One suggestion is to move the lens by a distance equal to 1/200 of its focal length. The correct focus for infrared cannot be obtained by visual focussing, since eye is blind to these longer rays. Fair correction may be obtained by focussing through a deep red filter. Some latest models of cameras have a red dot on the focussing scale to indicate the average correction for infrared photography.

Since infrared emulsions are sensitive to the blue region of the spectrum, as well as to a part of the red and to the near infrared region, filters are placed over the camera lens to absorb the unwanted rays, for taking the infrared records. Varied infrared effects can be obtained by the use of filters which transmit different wavelengths of spectrum. The spectral transmission characteristics of the filters should be consulted before using them.

## Infrared colour photography

Infrared photography is accomplished with a colour film sensitized to infrared. Infrared colour film has three image layers sensitized to green, red and infrared instead of to blue, green and red, as in the ordinary colour film. A Kodak Wratten yellow filter No. 12 is used on the camera to withhold blue, to which these layers are also sensitive. Upon processing, a yellow positive image records in the green-sensitive layer and positive images of magenta and cyan appear in the red and infrared-sensitive layers, respectively (Fig. 2).

Blue can be formed in the transparency, even though blue has been excluded from the image by the yellow filter. When the yellow image in the green sensitized layer is bright, magenta and cyan will predominate and will combine to form blue. Numerous other colours can be formed, depending upon the proportion of green, red and infrared reflected or transmitted by the subject. Leaves

**Fig. 4. Portion of a Dead Sea scroll so badly blackened by aging that the writing is absolutely illegible; shown in panchromatic-reflection photograph** *(left)* **and infrared reflection photograph** *(right)*

record red because they are "bright" in infrared. This brightness produces a light-toned cyan image which allows red from the other layers to predominate.

A visible-light component is also added to the infrared record. The resulting tansparency is a modified colour rendition of the subject. The film produces characteristic colours in the photographs of many physiological and botanical substances. Modified colour photography offers a new way to study infrared phenomena.

Colours produced in an infrared photograph cannot appear the same as it does in the original. For instance, an infrared photograph of a spectrum in a rainbow will not reproduce the original colours in the same relative position. A diffraction fringe in a microscope field may visually exhibit a blue, a green, and a red zone. In an infrared colour transparency the blue zone disappears, the green zone becomes blue, the red zone becomes green, and an infrared component of the fringe becomes red. So the visual blue, green and red colours are reproduced, but they are not observed at the same positions as in the original diffraction fringe; they are displaced to the adjacent band in the fringe.

## Applications

Infrared photography has many interesting and valuable applications in amateur, scientific and industrial fields because objects which absorb certain colours of visible light may reflect infrared rays to a marked degree.

The chlorophyll of green leaves absorbs most of the visible light except green, but acts as a good reflector of infrared. So green leaf foliage, recorded in dark shades of grey with ordinary and panchromatic films, appears in tones of light grey or even white when photographed with infrared. (in b & w) Since there is little infrared scattered from the blue sky, due to less exposure by the infrared rays, the density on the infrared negative is low giving midnight black tone in the positive print. An infrared photograph therefore may exhibit a very different tone rendition from that seen

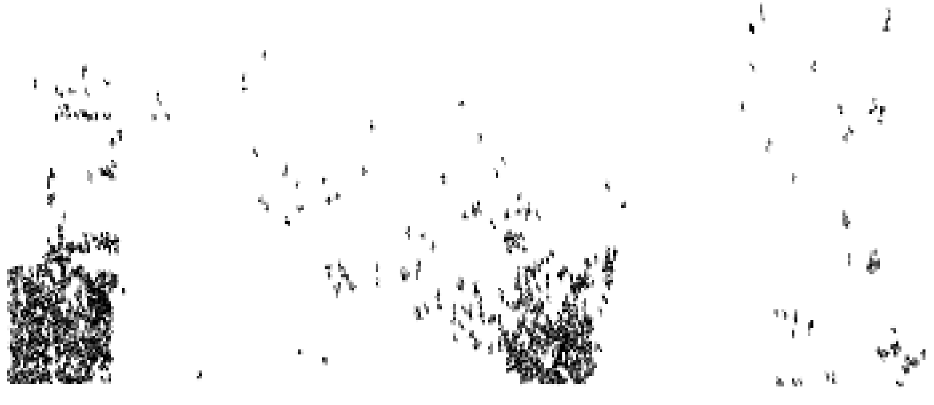


**Fig. 5. A burglar photographed by a hidden camera in infrared**

by the eye or as recorded on an ordinary film (Fig. 3).

The importance of infrared rays in landscape photography lies in their ability to penetrate light mist and atmospheric haze far better than visible light. Fig. 4 shows a comparison of an infrared rendition (*right*) with the panchromatic record (*left*), which reveals the ability of infrared photography to "penetrate" haze. The objects are well defined in the infrared photography for the following reasons: (i) the longer wavelength infrared is scattered somewhat less than visible red light; (ii) the infrared reflectivity and absorption characteristics of natural objects usually enhance the subject contrast; and (iii) the ratio of object brightness to atmospheric brightness is usually increased by higher reflectivity of infrared radiation by the landscape.

The haze-penetrating property of infrared rays finds a ready use in high-altitude aerial photography. Details entirely invisible to the eye may be revealed which could be of great value in making maps or in military reconnaissance. On the other hand, infrared rays suffer more absorption and so lose their penetrating properties as the size of the suspended particles increases. Their penetrating property in the case of fog or heavy mist is no better than that for visible light.

An important application of infrared photography is to make simulated or artificial moonlight scenes by taking photographs in daylight. This infrared technique is now widely used in the motion picture industry. There is considerable saving in production costs as well as simplification in the execution of many details involved in picture-makng when working by daylight as compared with that at night.

Although the use of infrared in making portraits of people gives unusual effects, the results are not flattering. Infrared penetrates living tissue to some degree and can be used to reveal subsurface details of skin such as varicose veins. So in medicine it offers a new tool in the diagnosis of many bodily afflictions. Medical infrared photography finds use in the detection of breast cancer, in the diagnosis of vascular tumours, for the delineation of circulatory patterns, in the evaluation of blood characteristics, and in dermatology, ophthalmology, and liver pathology.

Infrared photographs aid the study of distribtuion of heat over hot bodies, which is of interest to a design engineer. An interesting experiment consists in photographing two hot flat-irons which are at a temperature just below the red heat.

In criminology, the use of infrared technique in photographing an altered or charred document, a forged signature, blood stains and other objects in question often reveals details invisible to the naked eye. Infrared photography has proved to be a powerful tool in the solution of crimes when used by a trained investigator. Documents that have become charred by fire and ancient and recent subjects blackened by age, dirt or stains (Fig. 5) can sometimes be deciphered in an infrared print. Decipherment of papyri and investigation of papers surviving wilful attempts to burn them are both aided by infrared photography.

The capability of making infrared photographs "in the dark" offers opportunities for three major types of investigation : (i) studying human and animal behaviour without invalidating the experiment by disturbing the light-dark cycle; (ii) pupillography, in which eye responses can be recorded without interference from a visible light source; (iii) surveillance in law enforcement, in which evidence can be gathered without the knowledge of those committing the offence. Fig. 6 shows a burglar photographed in dark by a hidden camera in infrared.

In the field of science these invisible rays have opened up a new method of attack which has proved quite fruitful in several instances. One of the outstanding applications is in astronomy, where the use of a spectrograph in conjunction with infrared film has made possible the discovery of many new stars which are invisible to the eye. Photomicrographic techniques used in botany, entomology, histology, and embryology have been improved and extended by means of infrared.

## Further reading

1. Clark, W. and Gibson, H. L., *Photography by Infrared*, 3rd ed., John Wiley and Sons, New York, 1978.
2. Newman, A.A *Photographic Techniques in Scientific Research*, Vol. II, Academic Press, London, 1976.
3. Choromokos, E., Kogure, K. and David, N., Infrared absorption angiography, *J. Biol. Photogr. Assn* 37, 100 (1969).
4. Engel, C. E., *Photography for the Scientist*, Academic Press, New York, 1968.
5. Casida, L.E., (Jr.), Infrared colour photography, *Science*, 159, 199, 1968).
6. Simon, I., *Infrared Radiation*, D. Van Nostrand Co. Inc., Princeton, 1966.
7. Hackforth, H. L., *Infrared Radiation*, McGraw-Hill, New York, 1960.
8. Massopust, L. C., *Infrared Photography in Medicine*, Charles C. Thomas, Publisher, Springfield, 1952.
9. Rawling, S. O., *Infrared Photography*, Blackie and Son. Ltd., London, 1945.

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# INDUSTRIAL CATALYSTS

## AND THEIR MECHANISM

N.C DATTA

**By offering its surface as an alternative reaction site, through chemisorption, a catalyst changes the reaction path which involves less activation energy**

CATALYSTS are a wonder of chemical science They are a group of chemicals, which by their presence in a reaction accelerate the reaction rate enormously remaining chemically unchanged at the end of the reaction

Take, for example, the case of hydrogen and oxygen Under ordinary conditions they will react so slowly that it may take a million years to form a drop of water But introduce a piece of heated platinum foil, the two will react violently with an explosion and rain of water droplets Similarly, hydrogen peroxide is a stable liquid under normal conditions But in contact with platinum, manganese dioxide and some other substances, it starts decomposing with the formation of water and oxygen

Catalysts are widely used by chemical industry to accelerate hundreds of chemical reactions which are otherwise too slow to be commercially feasible Before 1913 ammonia could be manufactured mainly by the cyanamide process, there were only a few plants in the whole of west and total world production was only about 4000 tonnes of N per year With the introduction of catalytic Haber process the number of plants rose to 125 within 30 years and capacity increased by more than 1000 times to 4 5 million tonnes of N per year Similarly, in numerous other chemical industries producing acids, fertilizers, inorganic and organic heavy chemicals, and key materials like gasoline, LPG, solvents, plastics, foams, detergents, etc, the use of catalysts has either opened up new process routes or revolutionised the existing processes in terms of economics and efficiency and has radically changed the industrial scenario The use of catalysts is so pervasive today that nearly 70% of modern chemical processes are based on it at some stage or other and 90% of new processes developed are catalytic in nature

## History of development

The word *catalysis* was first used in a text-book of the 16th century, *Alchemia* (1597) However, as such it was being practised from antiquity for fermentation of grains to yield beverage preparation of vinegar from alcoholic liquids, and esterification-etherification of alcohols with the help of sulphuric acid The use of solid catalysts is comparatively recent It was only at the end of the 18th century that clays were used in alcohol dehydrations and metals in dehydrogenations In the first half of the 19th century the versatile catalytic action of platinum was noticed by several prominent scientists including Davy in 1816, Dulong and Thenard in 1823, Faraday in 1833 and Berzelius in 1834-35 It was Berzelius who used the term catalysis in 1835 to a group of chemical reactions whose rates were accelerated by the presence of foreign substances like acids, bases and platinum

The first patent on a catalytic reaction was taken by A D Phillips in 1831 for the oxidation of sulphur dioxide to sulphur trioxide in presence of platinum, but it took another 67 years to understand and control the poisoning of Pt by As, S, etc The first commercial plant for sulphuric acid manufacture by contact process was set up in Germany in 1898

The beginning of the 20th century saw some great men like Haber

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Sabatier, Ostwald and Langmuir work on the utilisation of solid catalysts for industrial purpose and elucidate their mechanism. Out of these efforts came the nickel catalyst for hydrogenation of fat which was commercialised in 1902, platinum-rhodium catalyst for ammonia oxidation (Ostwald received Nobel Prize for this in 1909), alkali-promoted iron catalyst for ammonia synthesis (Haber was awarded Nobel Prize in 1918 for the discovery of this catalyst), and chromia promoted iron oxide catalyst for water gas shift reaction. All these catalysts were put into commercial operation before World War I.

Later, researches by E. J. Houdry and others of the U.S.A. made a major breakthrough in the application of catalysts in petroleum refining. Acidic catalysts based on silica-alumina and other materials were discovered in 1930s and 1940s for isomerisation, dehydration, dehydrogenation and reforming of petroleum fractions (the first catalytic cracking unit was commissioned in 1938).

Post-World War II period saw the petrochemical industry placed on firm footing with the formulation of organo-metallic catalysts by Ziegler and Natta (Nobel Prize, 1963) for polymerising olefinic and alkylaromatic fractions derived from refinery units to synthetic plastics, rubber and other industrial materials. Today petrochemical industry is the biggest user of catalysts followed by fertilizer and other industries much behind.

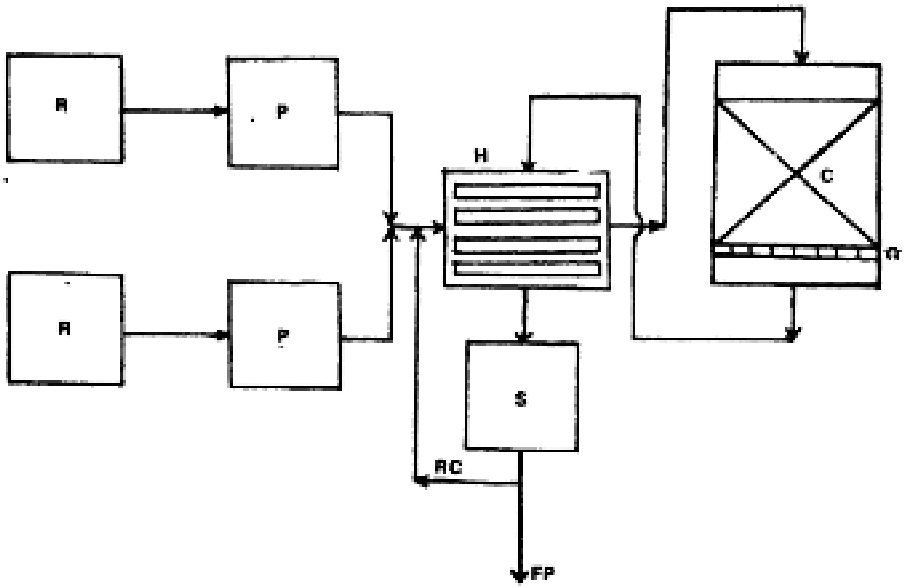

**Fig. 1. General flow sheet of a reactor ; R-reactants ; P-purification steps ; H-Heat exchanger; G-grid; C-catalyst; S-separator; Rc-Recycle; FP-product**

## Types of catalysis

In almost all of the industrial applications the catalysts are solids, usually in the form of lumps, pellets or extruded rods, and the reactants are either gases or liquids. This is termed as heterogeneous catalysis. In homogeneous catalysis, the catalyst is present in the same phase as the reactants. Examples are numerous in the vast field of solution chemistry—esterification and hydrolysis, many redox reactions, enzyme action in fermentation and physiological processes. The living cell is a complex chemical factory which makes use of homogeneous catalysis by the special proteins—enzymes—to produce heat and work from food. But enzyme catalysis has not found much importance in chemical industry except in the fermentation of sugar molasses to yield alcohol.

## Catalytic reactor

Fig. 1 shows schematically the flow sheet of a catalytic reactor. In the reactor the solid catalysts are placed on a strong refractory grate upto certain height and gases are introduced at the top of the converter under design operating conditions. These are fixed-bed converters used in many heavy chemical industries like fertilizer, sulphuric acid, etc. In moving or fluidised bed reactors, fine particles of catalyst and the feed stream flow opposite to each other. Such reactors are widely used in petrochemical industries, and other operations where catalyst regeneration is necessary at periodic intervals.

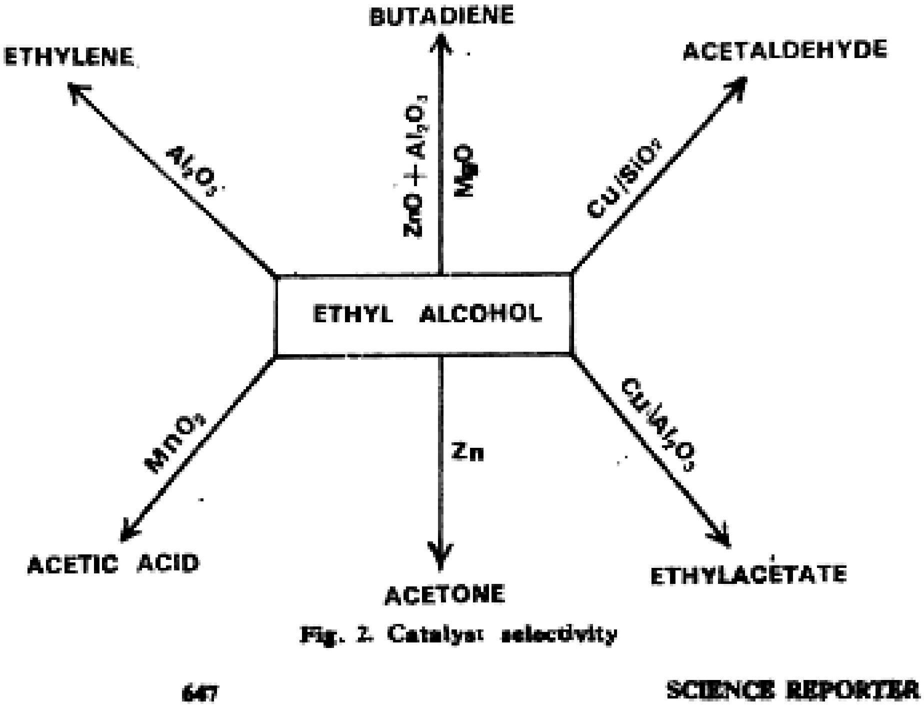

Fig. 2. Catalyst selectivity

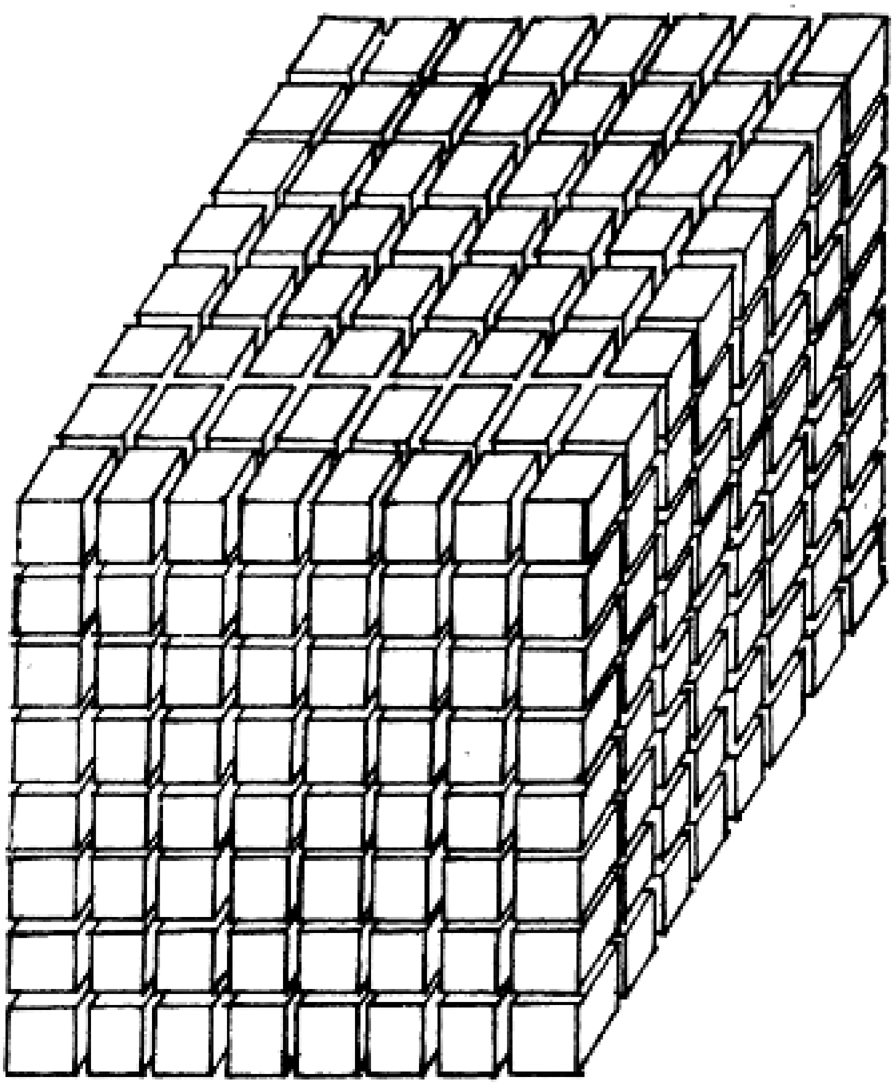

Fig. 3. Generation of surface by dividing a bigger particle into smaller particles

In some reactions like hydrogenation of oil to vanaspati, a slurry of finely divided catalyst is made with the oil and purified hydrogen is passed at the desired pressure and temperature for a certain period of time. After the reaction is over, the product is discharged and catalyst filtered out and the vessel is made ready for the next batch of the reaction. In a somewhat similar manner the polymerisations of organic compounds to plastics and rubber are carried out.

## Catalyst activity and selectivity

The most important criteria for selecting a particular catalyst for a process are its activity and selectivity. Activity, in simple words, is measured by the fraction of the reactants converted in a certain period of time. In case of reactions where a number of products are formed simultaneously (this is a feature of most organo-chemical reactions) selectivity of a catalyst denotes its ability to pick up one particular reaction while, at the same time, decelerating or suppressing the others. Fig. 2 illustrates how from ethanol different products are produced by different catalysts under different conditions. Selectivity of a catalyst with respect to a particular product is estimated by the ratio of the yield of that product to the total yield of all products by the catalyst.

## How a catalyst acts

The order by which a catalyst accelerates the rate of a reaction is often fantastic. It is now established that the enormous increase of the reaction rate by catalysis is possible through the introduction of a surface (the boundary of atomic thickness between the solid phase of the catalyst and the surrounding gaseous or liquid phase) into the reaction system. Non-catalytic reactions occur in the entire volume of the reaction vessel, i.e., it is three-dimensional in character; but catalytic reactions are two-dimensional, confined to the surface only. It may seem a bit surprising that the loss of one dimension in the availability of the reaction space increases the reaction rate by a million-fold or more; but on close examination this will not appear to be so.

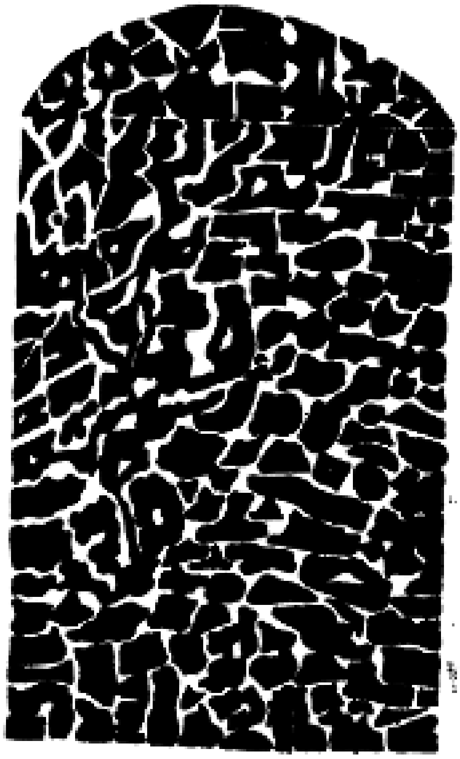

Fig. 4. Schematic diagram of a catalyst pellet interior (vertical section)—Open spaces indicating pores and filled spaces indicating solid grains

## Origin of surface

A catalyst contains enormous surface area within its solid matrix. For example, one gramme of silica-alumina catalyst contains 300m$^2$-500 m$^2$ surface which is the area of a moderate size swimming pool. Consider a cube of 8 cm side. It has a surface of only $6 \times 8^2 = 384$ cm$^2$. Let each edge of the cube be divided into 8 equal divisions with the help of a sharp instrument (Fig. 3). We get a total of $8^3 = 512$ cubes of each side being equal to 1 cm and the total surface area becomes equal to $6 \times 1^2 \times 512 = 3072$ cm$^2$, most of the surface originating in the interior of the cube. In case of micron-sized cubes obtained from the same cube of 8 cm side, the total surface area becomes : $6 \times (10^{-4})^2 \times (8 \times 10^4)^3 = 30,720,000$ cm$^2$. That is, as the particles become finer, the surface area increases rapidly.

In fact, a solid catalyst is a mass of irregular-shaped fine particles consolidatd into different geometrical shapes—cylinders, spheres, rods, rings, pellets, etc., where these tiny particles are bound together by adhesive forces leading to the formation of a highly porous honeycomb structure with a large internal surface confined within the pore-walls (Fig. 4).

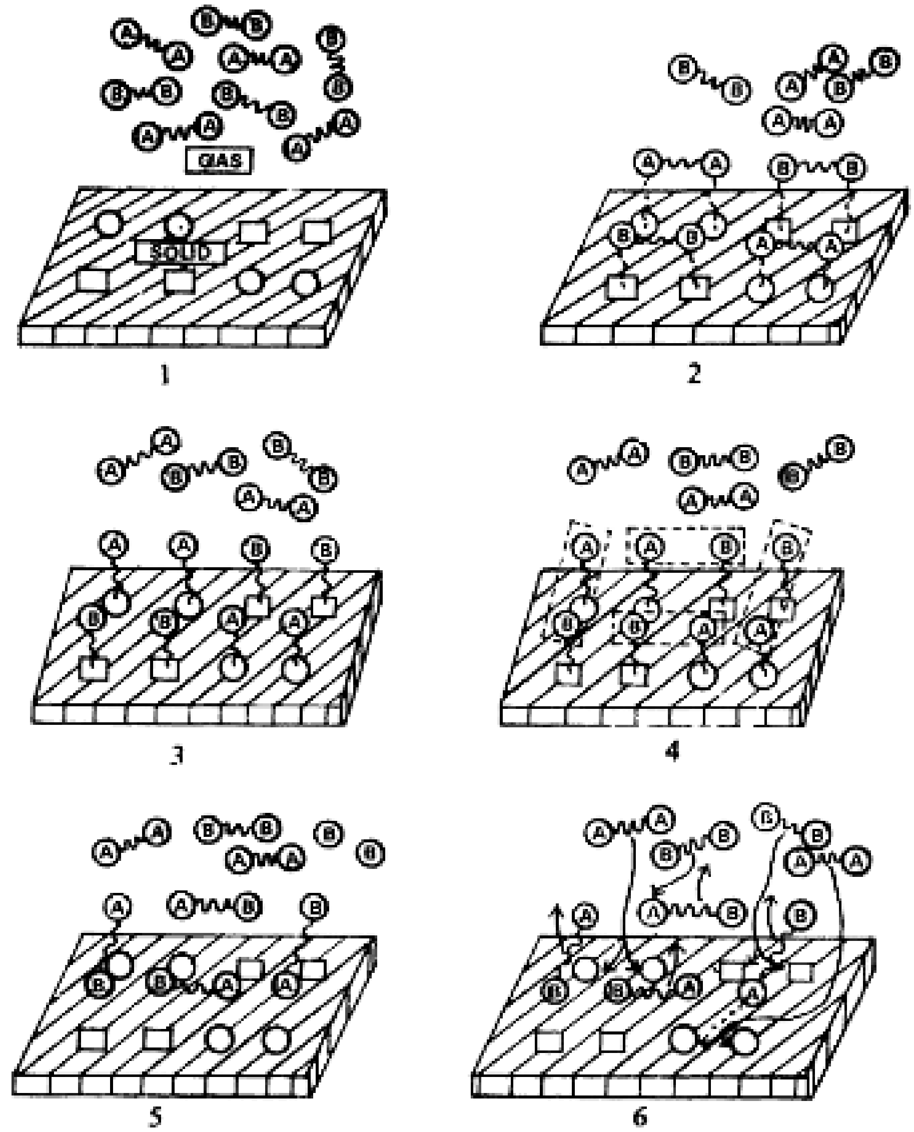

**Fig. 5. Model of a hypothetical catalytic reaction $A_2 + B_2 \rightleftharpoons 2\,AB$; (1) Active sites and gas before adsorption; (2) Transition state before adsorption on active sites; (3) Adsorption (formation of bond with active sites); (4) Transition state before surface reaction; (5) Surface reaction (formation of bond between absorbed atoms); (6) Desorption of product molecules and adsorption of reactants on freshly vacant sites**

## Adsorption

Though it never appears so to the naked eye, the surface of a solid is seldom composed of the components of that solid alone, except in vacuum and ultra-clean conditions. Clays take up gases and liquids when exposed to them. A clean foil of metal, when exposed to atmosphere, will be covered with oxygen in no time, so much so that the surface layer is metal oxide while pure metal is present inside. The surface contains atoms, edges, corners, cracks, dislocations, impurity, etc. (all termed as active centres) which, owing to their peculiar chemical and topographical nature, have some unsaturated valence forces and molecules coming into contact with surface are held by these forces to the surface; this is adsorption. As a result, the surface is covered by atoms and molecules with the formation of adsorbed layers.

The adsorbed atoms and molecules may form a monolayer, i.e., a layer consisting of one atom or molecule thickness, as envisaged by I. Langmuir in 1916 (Nobel Prize, 1932), or they may form multilayers. In multilayer adsorption, one layer of adsorbed molecules is built up over another until the layer becomes so thick that condensation to liquid state occurs.

Sometimes adsorption can be fast with rapid establishment of equilibrium between the surface and the gas molecules. The energy change involved is rather small and the molecules are held to the surface by long-range dispersion forces (similar to those operating in liquids). This is termed as physical adsorption or physisorption.

Adsorption may also be slow and monotonous with time involving a rather large energy change (heat of

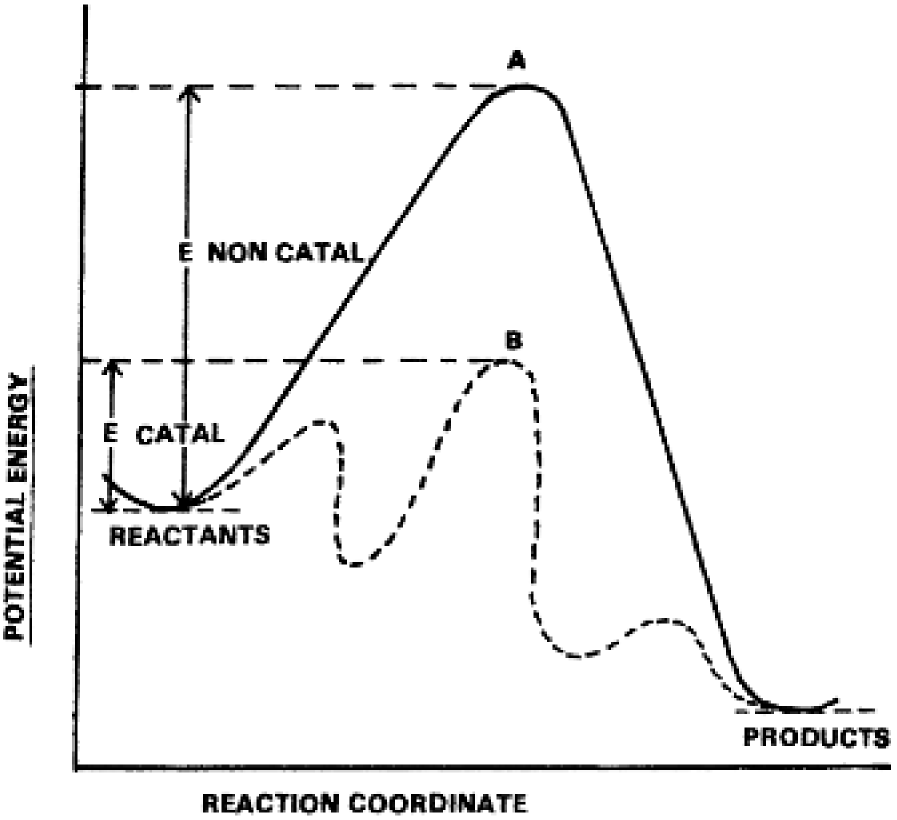

**Fig. 6. Potential energy diagram for a reaction occurring in catalytic and non-catalytic ways**

adsorption being of the same order as that of chemical reaction) In this case an exchange-type force operates at the surface dealing with charge-sharing or charge transfer between the solid surface and gas molecules This is chemical adsorption or chemisorption. Chemical adsorption, in true sense, is the precursor of catalytic reaction.

## Steps in catalysis

Any catalytic reaction proceeds along the following steps :

(i) diffusion of the reactant molecules from the bulk reactant phase to the catalyst surface through the surface film ;

(ii) transport of the reactant molecules through pores to catalyst surface ;

(iii) adsorption of the molecules on the surface--the molecules may be dissociated into atoms during the process ;

(iv) surface reaction among the adsorbed species (atoms or molecules) involving the breaking of bonds and formation of new bonds among them ;

(v) desorption of the product molecules from the catalyst surface ;

(vi) transport of the desorbed molecules through pores from the interior to external surface , and

(vii) diffusion of products through surface film to the bulk phase surrounding the catalyst.

Among these seven steps, adsorption, surface reaction and desorption have been found to be most important in almost all catalytic reactions. Fig. 5 illustrates schematically these elementary steps for a hypothetical catalytic reaction: $A_2+B_2 \rightleftharpoons 2AB$.

The surface reaction itself can occur by any of the three mechanisms : (i) interaction between molecules chemisorbed on adjacent sites; (ii) interaction between one molecule chemisorbed and one molecule physisorbed; (iii) one reactant molecule being firmly anchored at the surface which initiates and propagates chain extending well into the surrounding gas phase.

## Catalyst changes reaction path

According to Arrhenius concept of reaction rate (1887), any chemical reaction is controlled by two factors: frequency factor and activation energy. Accordingly, rate is increased if the former is increased and the latter is lowered. A catalyst essentially performs these two functions, that is, it

**Fig. 7. Reformation (catalysts extruded mass) used for reforming natural gas and steam into a mixture of CO, $CO_2$ and $H_2$**

**Fig 8** Methanation catalyst (size 6 mm dia × 6 mm height) used for converting CO and $CO_2$ into $CH_4$ before synthesis gas ($N_2 + H_2$) is fed to ammonia converter

increases the frequency factor and decreases in activation energy This is done by altering the normal reaction path which accelerates the rate enormously

Fig 6 shows the potential energy diagram for a reaction occurring in both catalytic and non-catalytic ways A simple calculation based on absolute rate theory yields for 1 $cm^2$ of surface

$$\frac{\text{catalytic rate}}{\text{non-catalytic rate}} \approx 10^{-12} \exp [E_{\text{non cat}} \quad E_{\text{cat}}] /RT$$

Thus is, either the availability of 100,000,000 $m^2$ of surface or decrease of activation energy by about 117 6 $kJ\text{-}mol^{-1}$ with the introduction of the catalyst would make the two rates equal at room temperature In practice, the activation energy decrease is of the order of 100-200 $kJ\text{-}mol^{-1}$ and the quantum of surface available from a given volume of a catalyst is quite high Except ammonia synthesis catalyst, most of the catalysts have surface areas from 10 to $m^2$ 500 $m^2$ per gramme. Moreover, catalysts usually operate at elevated temperatures, sometimes at 800 K-1000 K.

By offering its surface as alternative reaction site, through chemisorption, a catalyst changes the reaction path and the new path involves less activation energy The occurrence of a reaction is like crossing a hillock which, in most cases, is to be done by all the way going uphill to the summit, then going downhill to the other side, catalyst provides an alternative path along the side of the hillock by which going to the summit can be avoided.

## Further reading

1 Rideal, E K *Concepts in Catalysis*, Academic Press (1968)
2 Bond, G C, *Catalysis by Metals*, Academic Press (1962)
3 Thomas, J M and Thomas, W J., *Introduction to the Principles of Heterogeneous Catalysis*, Academic Press (1967)
4 *Discussions Faraday Society*, Vol 8 (1950)

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**S. N. GHOSH**

# BASICS OF INSTRUMENTATION

**Instruments and instrumentation by which phenomena are predicted or controlled evolve from multidisciplines and technologies**

MEASUREMENT by an instrument which gives a number usually involves a single observation. On the other hand, by the use of instrumentation a quantity is monitored over a period of time and the data are recorded. Instruments and instrumentation by which phenomena are predicted or controlled evolve from multidisciplines and technologies. The subject is known as 'metrology' which is rapidly developing, changing in concept with the scientific progress. The importance of measurement of scientific parameters is well-known. It guides an investigator, scientist or an engineer and shows success or failure in his effort. Without proper measurements the progress of science would have been retarded and persons practising science would not make progress in their trades. In this connection one should remember the oft-repeated definition of measurement by an instrument as given by Lord Kelvin which runs as follows:

"When you can measure what you are speaking about and express it in numbers you know something about it, but when you cannot express it in number your knowledge is of a meagre and unsatisfactory kind; it may be the beginning of knowledge but you have scarcely in your thought advanced to the stage of science, whatever the matter may be."

The above statement is very true for scientific measurements by instruments. A qualitative judgement is a poor substitute for quantitative measurement.

Even fifty years ago, there was a widespread feeling that an instrument could only be made by technicians who had only some knowledge of basic science, properties of materials and skill of handling certain machines like drill, lathe, etc. There was hardly any department in an university devoted to the study and research in instruments. With the advancement of instrumentation and process control and demand for sophisticated instruments the idea has considerably changed. People now realise that very skilled personnel and techniques are needed for their manufacture. Many universities have set up departments of instruments and instrumentation.

Two basic requirements of a measurement are : (i) measuring system should not affect the quantity to be measured; and (ii) the quantity to be measured should not affect the measuring system.

In other words, interaction between the measuring instrument and the system whose parameters are to be measured should be small. The interaction involves an expenditure of energy. For example, to measure a force acting on a body we make it

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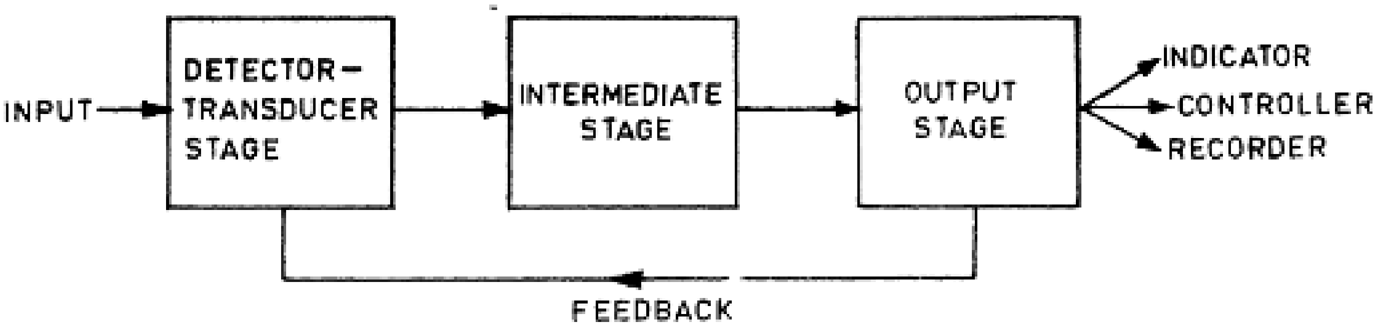

Fig. 1

undergo a displacement In doing so an amount of energy is drawn from the system, which should not alter the force to be measured.

## Electronic instruments

Presently electronic instruments are widely used in all branches of science and engineering. The primary function of an instrument is to measure a quantity directly as in weight measurement by a spring balance, or by comparison as by a common balance The information thus obtained is then fed to an indicator, recorder or a controller. In electronic instruments inputs are primarily in the form of electric signals. The technique has the following advantages.

(i) Handling of data is easy. They can be readily amplified, attenuated or altered; (ii) Mass-inertia effects are small; (iii) Remote indication is feasible; (iv) Sufficient output for controlling initiation is available; and v) Miniaturization is possible.

The two basic functions of an electronic instrument are measurement and control. They are carried out with the experimental set up shown in Fig. 1.

(i) *Detector-transducer stage*—its primary function is to receive the signal in one form of energy and to transform it into a different or similar form of energy.

(*ii*) *Intermediate stage* which accepts the signal from the detector-transducer stage and modifies it so that it can be suitably handled by the output stage.

(*iii*) *Output stage* which further modifies the signal so that the function of indication, recording or controlling depending upon the actual requirement can be carried out.

## Feedback control

The response of an instrument is an important property. In certain cases such as in the process control industry, 'lag' in the measurement not only leads to incorrect operation of the system, but also adversely affects the overall performance. By incorporating feedback faster response can be achieved. In addition, higher accuracy and immunity to external disturbances is obtained. In automatic operation one or more variables is sensed and made to actuate some component of the instrumentation system and thereby control the operation automatically. A typical example is the continuous automatic control of forehearth temperature in glass or ceramic industry. In this case the molten glass is prepared in the forehearth whose temperature is to be controlled to within a fraction of a degree. This can be achieved with the help of a conventional potentiometer - recorder-controller using electronic amplifier or with the help of a solid state electronic amplifier using a reference signal.

## Transducers

They are energy conversion devices. In fact, they are the heart of an electronic instrument and distinguish one electronic instrument from another, the other parts being more or less similar. Transducers are classified into two broad categories, self-generating or active and non self-generating or passive transducers

Self-generating or active transducers produce an energy output for a single energy input, e.g., thermocouples, photovoltaic cells. On the otherhand, non self-generating or passive transducers require additional sources of energy to produce outputs dependent upon the primary input, e.g., resistance thermometers, strain gauges, photoelastic devices, differential transformers. These latter transducers are also referrred to as 'coducer'

Because of the various combinations of energy conversions the total number of transducers is very large. All forms of energy can be conveniently divided into the following eight basic groups :

1. Mechanical
2. Acoustic
3. Thermal
4. Electromagnetic
5. Electrical
6. Magnetic
7. Chemical
8. Nuclear.

## Space instrumentation

The excellency of electronic instrumentation is afforded in detecting, measuring and controlling space parameters. Before we come to the recent trends of space investigation, we may consider the basic characteristics of space research as given below :

1. Space research is presently primarily exploratory in nature in contrast with investigation in the 'fundamental science phase' which attempts in processing the science of the phenomenon discovered during exploratory phase. Hence planning of experiments for space research

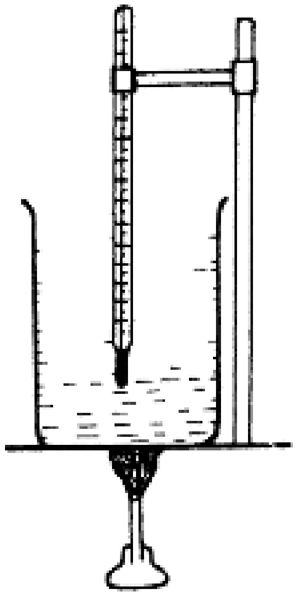

Fig 2 Laboratory technique of measurement of a parameter in which the measuring instrument comes in contact with the phenomenon whose parameters are to be measured

involves considerable uncertainty

2 The investigations of space research sometimes are to be carried in parameter range far beyond that can be realized in laboratory

3 Within space at its different regions, phenomena of very different nature and character take place

4 The 'probing techniques' in which measuring instruments do not come in contact with the phenomena whose parameters are intended to be measured (Fig 2) are sometimes adopted for space investigation (Fig 3)

5 Rocket experiments which are performed under controlled conditions and are of one-shot nature, are sometimes adopted for space investigation Because of small time available for carrying out an experiment, the basic conflict of rapid response and high sensitivity arises. Again, continuous observations cannot be obtained and hence by rocket experiments synoptic measurements are carried out.

6. If experiments are carried out aboard satellites or space labs., more time will be available for carrying out experiments and hence difficulties associated with rocket experiments can be overcome.

Considering trends of future space programme vis-a-vis the measurement technique, it appears that there will be three requirements in almost all future space missions, and in retrospect can be seen in past missions also They are

(i) *Large number of space crews.* As time passes space missions will involve larger number of space crews Project Mercury involved one man, Gemini two men, Apollo three and Skylab involved several scientists requiring integration of human monitoring and life supporting instruments.

(ii) *Longer operational periods* Space missions require longer operational periods. Earth satellite missions involve several weeks or a month, mission to moon several days, to Mars well over a year and to Jupiter and Neptune requiring four or more years

(iii) *Increased payload and larger number of complex equipments* The third trend involves increase in payload and larger number and variety of complex and sophisticated equipments. There is a spirally increasing demand for more measurements, and hence for more instruments.

The three basic trends can be translated into several fundamental instrumentations and measurements. One of these is to obtain more information rather than few data. Secondly, longer mission time and more extensive human involvement demand greater need for instrument reliability and life. The need for improved resolution, accuracy and sensitivity are obvious. Outputs compatible with telemetry and suitable for quick on-line display are needed. Furthermore, standardization and calibration, particularly calibration during long-term missions are required

To make future space missions successful, it is necessary that adequate instruments for the particular job be available. Finding the best instrument for a particular job is a continuous process involving research, development and testing Sometimes 75 per cent of the users find it necessary to build their own instruments because the proper ones are not available

To meet these needs we should use known physical effects and those which are being discovered, and in addition, we should review conti-

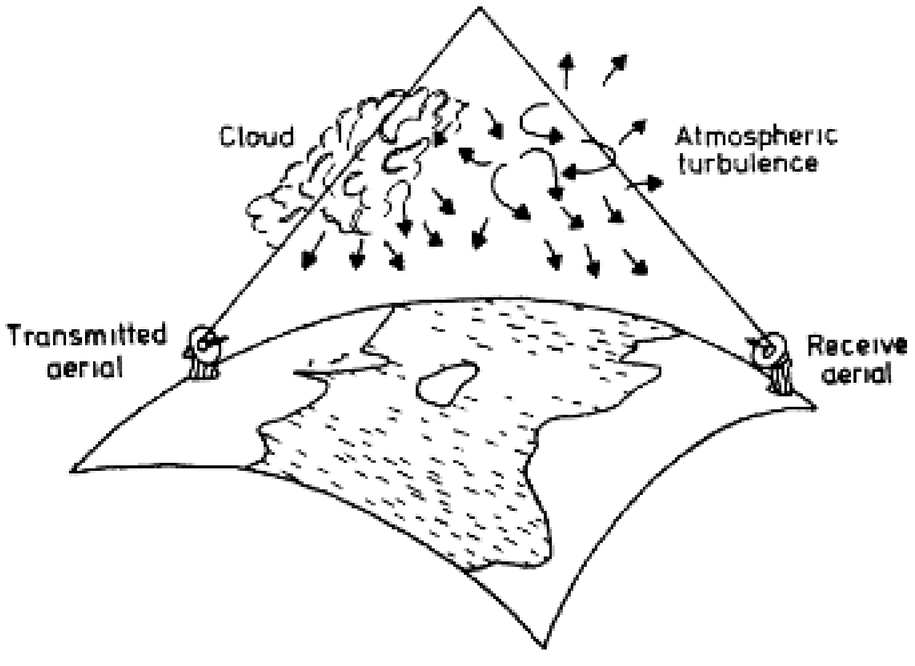

Fig. 3. Probing technique of measurement. The measuring instrument does not come in contact with phenomenon whose parameters are to be measured

**Table 1. Transducers and quantities to be measured**

| *Physical principle utilised* | *Transducer* | | Quantity to be measured or controlled |
|---|---|---|---|
| | *Active* | *Passive* | |
| 1. Thompson Effect (Thermal to Electrical) | Thermocouple | | Temperature |
| 2. Peltier Effect (Electrical to Thermal) | Cooler | | -do- |
| 3. Thermoresistive Effect (Thermal to Electrical) | | Thermister | -do |
| 4. Hall Effect (Magnetic to Electrical) | | Haltron Transducer | Magnetic field |
| 5. Piezoelectric Effect (Mechanical to Electrical) | Piezoelectric pressure transducer | | Dynamic pressure |
| 6. Variable Inductance (Mechanical to Electrical) | | Differential transformer | Displacement, velocity or acceleration |
| 7. Variable Reluctance (Mechanical to Electrical) | Variable reluctance magnetic transducer | | Relative motion or speed |
| 8. Magnetostriction (Joule Effect) (Magnetic to Mechanical) | Magnetostriction transducer | | |
| 9. Magnetoelasticity (Mechanical to Magnetic) | Magnetoelastic transducer | | Measurement of heavy weight |
| 10. Magnetoresistivity (Magnetic to Electric) | | Bismuth Spiral | Magnetic field |

nuously the available scientific and engineering principles. Concepts which were originally only theoretically possible can now be realised in practice. Take the case of superconductivity which was discovered by Onnes in 1911. Only in the last decade, with advances in cryogenic technologies, it was possible to have useful instrumentation. Another example is the Hall effect which was discovered in 1879. In recent years with the advances in solid state devices it has been possible to design transducers using this effect.

New discoveries enable one to make measurements of quantities which could not do done earlier For example, after the discovery of Mössbauer Effect it is possible to measure the change of frequency of a photon while passing through a gravitational field as follows

Defining the mass $m = E/c^2$, where E is the energy of the photon and C is the velocity of light, a photon while passing through a gravitational field over a distance h, will change in energy by an amount $\delta E = mgh$ where $g$ is the acceleration due to gravity. The relative increase in energy

$$\delta E/E = gh/c^2 = 1.1 \times 10^{-16} h$$

which is too small to be measured. This gravitational red shift was proved through the application of Mössbauer Effect For $^{57}$Fe isotope for which the ratio of the line width to the energy of the γ-ray is 3.1 parts in $10^{13}$ and for $h = 44.4$ meters

$$\delta E/E = 1.1 \times 10^{-16} \times 44.4 = 5 \times 10^{-15}$$

which is only 5 per cent higher than the predicted value.

Another example is holography which was originally investigated by Gabor over 20 years ago. It had then limited use. With the advent and application of lasers it has now become a practical art and a serious contender for many measurements.

**New concepts are needed**

Consider the high vacuum which exists in space. For example there are only a few particles per cc in the interplanetary space. To measure accurately such high vacuum conventional pressure measuring techniques based on the statistical averaging of particle motions can no longer be used There are so few particles that their motion cannot be considered to be random and to give accurate statistical average There is need for a new method of measuring such low pressure

What is needed now is a conceptual and logical arrangement of measurements The aerospace measuring problems require a wider comprehension and better understanding of

(*Continued on page* [illegible])

# THE BALMER SERIES OF ATOMIC HYDROGEN

R.C. BHATT

**The spectrum of atomic hydrogen exhibits a remarkably simple pattern of lines that formed the basis of our understanding of the atomic structure**

IN the year 1885, a sixty year old school teacher in Basel, J.J. Balmer, discovered that the wavelengths of the spectral lines of hydrogen form a series which could be described by a single formula. More than two centuries elapsed between Newton's observation of the dispersion of white light by a prism (in the year 1666) and the achievment of any notable success in the interpretation of spectral regularities. Balmer's formula deserves great attention because it was destined to have a profound influence on the subsequent development of atomic physics.

Johann Jakob Balmer (Switzerland, 1825-1898) was born on May 1, 1825 in Lausen, a small town in the Swiss canton of Basel-Land. He had his schooling in Lausen and later he studied mathematics at the universities of Karlasruhe, Berlin, and Basel. He obtained his Ph. D. degree in mathematics from the University of Basel in 1869. Balmer became a schoolteacher at a girls' secondary school at Basel after spending some time as a private-dozent (an unsalaried university lecturer in German-speaking countries remunerated directly by students' fees) at the university of Basel. His work on hydrogen spectral lines was described in a series of papers that appeared in a Basel scientific journal and in *Annalen der Physik und Chemie* (a famous German scientific journal). Balmer died in 1898, just about three years before Max Planck (Germany, 1858-1947) discovered the quantum of action which was ultimately to give relevance to his empirical formula.

## Regularities in the line spectrum of hydrogen

Every element has a characteristic line spectrum which it emits when suitably excited in the gaseous state by heat or an electric discharge. While a continuous emission spectrum arises from hot solids, a line spectrum always arises from a gas at high temperatures. Since the line spectrum is a property of the atoms of an element, it is also called atomic spectrum of that element. Most of our knowledge of the electronic structure of atoms has been obtained by the study of light given out by atoms when they are excited by high temperatures, for example, in a flame or an electric arc. These line spectra had been thoroughly studied and mapped out long before there was any atomic theory that could explain them.

As early as 1868, Anders Jöns Ångström (Sweden, 1814-1874) published a map of the visible spectrum of the sun, and on this map he labeled the wavelengths in ten millionths of a millimeter. Since then, light waves have been specified in this unit called Ångström unit (abbrev. Å; 1 Å = $10^{-10}$ m). Some elements, such as iron, give dewilderingly complicated spectra containing hundreds of lines in the visible region alone. Others, the light elements and the alkali metals, in particular, give simple patterns of lines in which a certain regularity could be easily observed. Here was a rich store of information about atomic structure, if only it could be understood!

The spectrum of atomic hydrogen exhibits a remarkably simple pattern of lines. Historically, this simplicity provided the foundation of our present understanding of the atomic structure. Fig. 1 shows the visible portion of the spectrum of atomic hydrogen. This spectrum consists of the sequence of lines now known as the Balmer series. The reddish colour of a hydrogen glow discharge is due to the intense red line of wavelength $\lambda = 6563$ Å, the first line of the Balmer series.

Despite the simple appearance of the hydrogen spectrum, spectroscopists struggled for many years to account for the pattern of lines in it. The first study of the hydrogen spectrum from this point of view was reported in 1868 by George Johnstone Stoney (Ireland, 1826-1911). In further carrying out this research, Stoney found it convenient to refer the position of all lines in the spectrum to a scale of reciprocals of the wavelengths rather

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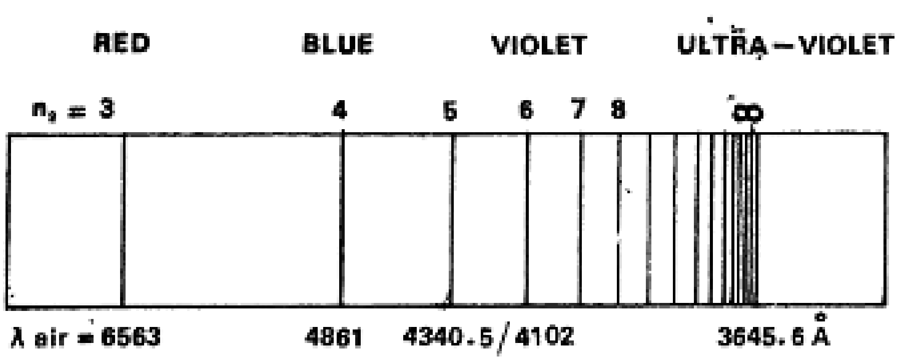

**Fig. 1. Balmer series of atomic hydrogen**

than the wavelengths themselves. Thus, Stoney, who afterwards in 1891 introduced the term "electron" in physics, was the first to use the important notion of "wave number" in 1871. Later, in 1881, Arthur Schuster (England, 1851-1934) stressed the importance of the search for "an empirical law connecting the different periods of vibration in which we know one and the same molecule to be capable of swinging". In 1882, Schuster concluded that "most probably some law hitherto undiscovered exists...". Three years later an empirical formula, the first to incorporate correctly all lines of a spectral series, was found by Balmer.

### Balmer's discovery

The essence of Balmer's discovery is that the wavelengths of the first four lines in the visible spectrum of hydrogen atom could be very accurately represented by the formula :

$$\lambda = b\,p \quad \frac{n^2}{n^2 - 2^2}$$

where *b* is an empirically determined constant equal to 3645.6 Å, and *n* corresponds to integers 3, 4, 5 and 6. Table 1 gives a comparison of Balmer's calculated values with the available measurements in 1885. The second column lists the wavelengths of the first four spectral lines as calculated by his formula, and the third column lists the same wavelengths as measured by Ångström. The coincidence of the measured and calculated values is amazing Such coincidences cannot happen by chance, and consequently, Balmers discovery led to a whole chain of new investigations.

His first paper in 1885 announcing the discovery of his formula, contained these prophetic words : "It appears to me that hydrogen... more than any other substance is destined to open new paths to the knowledge of the structure of matter and its properties. In this respect the numerical relations among the wavelengths of the first four hydrogen spectral lines should attract our attention in particular". Balmer was initially unaware of the existence of a fifth line and calculated its wavelength corresponding to $n=7$ in his formula, obtaining $\lambda=3969\ 65$ Å. A friend then informed him that not only was the fifth line (in the violet) well-known, but some additional lines had also been detected photographically in the ultraviolet region in the spectra of certain stars. In the second paper, in 1885 itself, Balmer was able to show that his formula applied to all the twelve lines of hydrogen then known. He also predicted correctly that in his series no lines of wavelength longer than 6562.1 Å would ever be discovered and that the series would converge at 3645.6 Å. The agreement between the calculated and the observed values of the wavelengths was extremely close in the visible region but for the shorter wavelengths where slight systematic discrepancies were evident. In view of these discrepancies Balmer expressed some doubt whether the fault lay with his formula or with the data. These discrepancies were subsequently removed when it was realized that the wavelength of a spectral line in air is slightly less than that in vacuum (depending upon the index of refraction of air for the wavelength in question).

### Other series in the spectrum of atomic hydrogen

In his second paper Balmer had also remarked: "None of the hydrogen lines which correspond to the formula when $2^2$ is replaced by $3^2$, $4^2$, etc., and which may be called lines of the third or fourth order, are found in any spectrum as yet known; they must develop themselves under entirely new relations of temperature and pressure if they are to become preceptible". Although Balmer had correctly pointed out that there must be other series of lines in the spectrum of hydrogen, he did not attempt to find them. However, soon after the publication of Balmer's work, intensive investigations in spectral series were initiated by Heinrich Gustav Johannes Kayser (Germany, 1853-1940) and Carl David Tolmé Runge (Germany, 1856-1927), and also by Johannes Robert Rydberg (Sweden, 1854-1919). Balmer's formula was subsequently transformed by Rydberg into the following general form used today :

**Table 1. Verification of Balmer's formula**

| *Value of n* | *Wavelength λ (Å)* | |
|---|---|---|
| | *According to Balmer's formula* | *Measured by Ångström* |
| 3 | 6562.08 | 6562.10 |
| 4 | 4860.8 | 4860.74 |
| 5 | 4340 | 4340.1 |
| 6 | 4101.3 | 4101.2 |

**Fig. 2. Spectral series of atomic hydrogen**

| *Value of* $n_1$ | *Values of* $n_2$ | *Name of Series* |
|---|---|---|
| 1 | 2, 3, 4,.... | Lyman |
| 2 | 3, 4, 5,.... | Balmer |
| 3 | 4, 5, 6,.... | Paschen |
| 4 | 5, 6, 7,.... | Brackett |
| 5 | 6, 7, 8,.... | Pfund |
| 6 | 7, 8, 9,.... | Humphreys |

$$\nu = R_H(1/n_1^2 - 1/n_2^2)$$

where $\bar{\nu}$ is the wave number ($\nu = 1/\lambda$), $n_1$ and $n_2$ are positive integers ($n_2 > n_1$), and the symbol $R_H$ is called the Rydberg constant for hydrogen. According to modern measurement, $R_H = 109677.58$ cm$^{-1}$.

As it turned out, Balmer's prediction of additional lines was essentially correct. In 1906, Theodore Lyman (USA, 1874-1954) observed one line of the series, now known as Lyman series, in ultraviolet region. Further series were discovered in infrared: the Paschen series discovered in 1908 by Friedrich Paschen (Germany, 1865-1940); the Brackett series discovered in 1922 by Frederick Brackett (USA, 1896—), the Pfund series discovered in 1924 by Hermann Pfund (USA); and the Humphreys series discovered in 1953 by Curtis Humphreys (USA, 1898—). Table 2 gives $n_1$ and $n_2$ values of these series; their wave numbers are given by the Rydberg formula. As we progress along a series towards shorter wavelengths, the subsequent lines appear fainter and their spacing decreases until finally it becomes impossible to distinguish the individual lines. In practice, we derive the series limit from the formula by setting $n_2 = \infty$. The number of series members that can be observed depends, among other things, on the conditions of the source of radiation. For the Balmer series, for example, typical laboratory spectrum may show lines upto $n_2 = 12$, whereas lines upto $n_2 = 33$ appear in the solar chromospheric spectrum. In some stars the series may be seen as far as upto $n_2 = 40$.

## Dawn of a new era

Balmer's discovery opened a new era in the science of atom. Like Kepler's laws of planetary motion, Balmer's empirical formula fitted in the experimental data well, but no one knew why! Its meaning lay hidden, until, like Newton who showed that Kepler's laws of planetary motion were the natural outcome of his own law of universal gravitation. Niels Henrik David Bohr (Denmark, 1885-1962) succeeded in constructing a general theory from which Balmer's empirical formula could be derived. A few years before Bohr's monumental work was accomplished, Walther Ritz (Switzerland, 1878-1909), in 1908, had introduced what is now known as "Ritz combination principle." According to this principle, the frequency (the speed of light divided by the wavelength) of every spectral line of an element could be expressed as the difference between two terms, or more properly, "spectral terms", each of which contained an integer. Ritz then went on to show that the fundamental sequence of numerical terms for any atom is obtained by dividing a certain numerical constant (which varies from one atom-type to the other) by the squares of the integers taken in turn. This remarkable sequence, which stemmed from the basic work of Balmer, was of great importance in leading finally to the development of a successful conceptual model of the hydrogen atom. This was achieved by Niels Bohr in 1913, when he was able to derive Ritz combination principle by applying Planck's quantum theory to the planetary atom model of Ernest Rutherford (New Zealand, Canada, England, 1871-1937).

Balmer was known to be interested in numerology from his school days. Like the ancient Pythagoreans, he was convinced that the mysteries of the universe could be explained with the help of appropriate combinations of integers. A story is told about him that, one day, while chatting with a friend (who happened to be a physicist or chemist), Balmer complained that he had "run out of things to do". Whereupon the friend replied: "Well, you are interested in numbers, why don't you see what you can make of this set of numbers that come from the spectrum of hydrogen", and gave Balmer the wavelengths of the first four lines of hydrogen spectrum. This perhaps led to the important discovery. The wavelengths of spectral lines really did turn out to be related by a simple equation having far-reaching consequences.

## Further reading

1. Richtymer, F. K., Kennard, E. H., and Cooper John, N., *Introduction to Modern Physics*, Sixth Edition, McGraw-Hill Book Company, New York (1969).
2. Kaplan, Irving, *Nuclear Physics*, Second Edition, Addison-Wesley Publishing Company Inc., Reading, Massachusetts (1963).
3. White, H. E., *Introduction to Atomic Spectra*, McGraw-Hill Book Company, New York (1934).
4. Darrow, K. K., The quantum theory, *Scientific American*, March 1952, Vol. 186, No. 3, pp. 47-54 and also *The Scientific American Offprint* 205.

# SCIENCE SPECTRUM

## Did Venus evolve like earth ?

DESPITE delicate legends about Venus, it is barren though it is of the size of earth and at almost the same distance from the sun. The surface of the planet is dry, hot and shrouded with a dense atmosphere. However, scientists have now found that these differences are only a matter of external appearances. But for the occurrance of rains (with consequent effects) on earth, all the processes, whether occurring inside or outside these planets are essentially the same. It is only the extent to which these processes went on made all the difference between the two. Most of the blame for the differences can easily be laid down on the dense atmosphere that Venus retained in its early stage of evolution and which makes it a unique planet in the solar system.

It is only in the last decade or so that astronomers have been able to have a peek at the surface of Venus by means of powerful radars. A beam of radio waves is directed at the planet and from the reflected waves the surface features of the planet are ascertained. Over the years the data that has been collected on the planet claims that its surface is almost uniform, about 60 per cent of it varies within one kilometer of the mean surface level of the planet, which in terrestrial terms is called the "mean sea level". The period of rotation of the planet is about 240 earth-days, its surface temperature is about 475° C and the atmospheric pressure at the surface is about 100 times that on earth

The reflectivity of the Venusian surface is about 15 per cent, which indicates that its surface material is not different in composition from some of the terrestrial rocks. Besides, the radar studies also show some features on Venus which have parallels on earth. In December 1978, however, a U.S. spacecraft *Venus Orbiter* went into an orbit of the planet and scanned about 93 per cent of its surface, a belt of Venusian land, between the latitude 74° North to 63° South, upto an accuracy of 200 meters. It is now beyond doubt that Venus has continents, mountains, volcanoes and other geological features seen on earth and other planets (*Scientific American*, August 1980).

The most extraordinary feature on the surface of Venus is the Maxwell Montes (after James Clerk Maxwell). It is a mountain 11 km in height which makes it taller than the Mount Everest. The mountain has an almost circular dark hole at the top, which indicates that at one time it might have been a volcano. On the west of Mount Maxwell is a rimmed, pear-shaped flat plateau, one of the largest smooth surfaces on Venus, called Lakshmi plateau. Both these features form a part of the Venusian continent, called Ishtar Terra (See Fig. 2). A counterpart of this continent is in the southern hemisphere of the planet. It has been named Aphrodrite Terra.

There are many other conspicuous

Fig. 1. Mount Maxwell as seen from earth

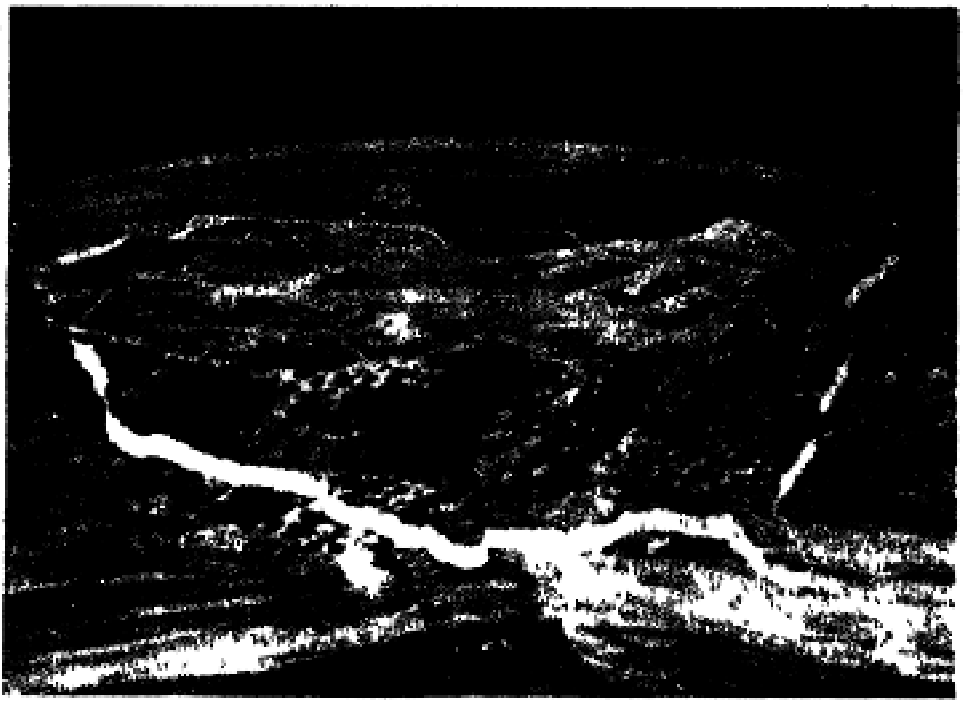

Fig. 2. An artist's impression of Montes Maxwell on Venus. On the left can be seen the smooth plateau, called Lakshmi plateau. A line drawing of the American continent has been superimposed on the illustration to give an idea of the size of the mount and plateau.

features on the surface of the planet. Alpha Regio (25° south, 0°) is a grainy feature running from north-east to south-west which is, in fact, a faulted basin range. Beta Regio is again a chain of mountains about 1,000 km long, each a remnant of a large extinct volcano as seen on Mars. The only conspicuous feature on Venus which has not yet been found either on earth or other planets is a furrowed, 1,000 km long arc found near the equator at 355° longitude The arc has two parallel ridges, each 2 km high, which are separated by a valley 90 km wide These high ridges are, however, tilted at an angle of 6° with the vertical—quite an impressive tilt by terrestrial standards The origin of these ridges is therefore still a mystery. More than a dozen ring-shaped structures have also been found on the surface of the planet. Whether these structures are modified craters or extinct volcanoes will not be clear until something concrete about the composition of Venusian surface material and the effect of the heavy atmosphere on the surface are known.

As Venus is of the size of earth and is about the same distance from the sun, it has been of tremendous interest to scientists of many disciplines. The data collected to date on the planet thus provide them something to compare with the processes that made earth, which would further give insights into the forces that come into play in the formation of other planets and smaller bodies in the solar system The most interesting question that scientists were keen to probe was whether Venus is far more spherical than earth because the former rotates about its axis far more slowly than the latter. The recent data has confirmed that this is indeed so.

Like earth, Venus has also been found to have tectonic activity on its surface. One of the prominent spots that exhibit this activity is a moderately straight valley found at the latitude 20° South and between longitude 150°-175° East, which is similar to faults seen in terrestrial rift valleys. In so far as the question whether Venus was, or is still, internally active or not like the earth, it is quite certain that it was so, but whether it is still so can only be said on further studies. The very dense atmosphere of the planet is a clear pointer to the fact that once when its interior was hot and in molten stage, it outgassed and produced the present atmosphere. The atmosphere contains proportionately a large amount of argon gas, which is a remnant of the primordial atmosphere of that planet. In other words, Venus retained its primordial atmosphere while earth did not. What were the factors working behind this and many others could only be sorted out on more intensive study of the planet. For this purpose the NASA has a plan to launch a *Venus Orbiting Imaging Radar* later in this decade. By means of radio waves the orbiting vehicle will give as much data on Venus as *Mariner-9* gave on Mars in the visible spectrum

DILIP M. SALWI

## Have quarks been found ?

THE detection of quarks became a rage since the quark model was first proposed by M Gell-Mann and G Zweig in 1964 It became a sensitive issue recently, when G.S. La Rue, W.M. Fairbank and J.D Philips of Stanford University, U S.A claimed the existence of fractional charges of quarks (*Physical Review Letters*, **42,** 142, 1979) with the improved version of the earlier experiment (*Physical Review Letters,* **38,** 1011, 1977). The concept that quarks are confined within the strongly interacting particles, known as hadrons, is the pillar of a theory known as Quantum Chromodynamics (QCD). The theory assumes that quarks cannot exist free in nature. Whereas a substantial number of physicists believe in the validity of QCD, the experimentalists, on the other hand, would no doubt be happy, could they prove the existence of free fractionally charged quarks. Which is what the recent experiment has indicated.

In their model, M. Gell-Mann and G. Zweig proposed that the constituents of hadrons are quarks having fractional charges of value $-\frac{1}{3}e$ and $\frac{2}{3}e$. The quark model has been successful in explaining the experimental results in high energy physics. However, physicists are not happy with the concept of fractional charge because it violates the results of classic oil drop experiment of R.A. Millikan performed in 1910. Millikan had shown that electric charge appeared only in integer multiple of a fundamental unit $e$, whose value is $1.602 \times 10^{-19}$ coulomb. Every elementary particle so far discovered has a charge $ne$ where $n$ is an integer $+1$, $0$ or $-1$, etc.

So the hypothesis that quarks have fractional charges offered a challenge to experimental physicists. From 1966 to 1970 several attempts to detect fractional charges were made but in vain. In 1974 E.D. Garris and. K.O.H. Ziock reported possible fractional charges. Unfortunately, the identification was uncertain in their case because of background dipole forces. However, stronger evidence for the existence of residual charges close to $\frac{1}{3}e$ and $-\frac{1}{3}e$ on two superconducting spheres was obtained by G.S. La Rue, W.M. Fairbank and A.F. Hebard in 1977. Their experiment was a continuation of the earlier work of Hebard and Fairbank. Now they have observed two more fractional charges with an improved apparatus. Their calculations indicate that no other electric or magnetic force could have mimicked the fractional charges.

Using low temperature techniques the aforementioned four physicists suspended a superconducting niobium ball ($\sim 9 \times 10^{-6}$ gm) in a magnetic field between two capacitor plates which were placed horizontally. Applying an alternating electric field between the capacitor plates the force applied to the ball was measured. To see that the fractional charges were not spurious, they determined all the background forces. They have also showed that the magnetic force could not account for the fractional charges observed ($\pm\frac{1}{3}e$).

The physicists conclude from their experiments on nine balls that they had fractional charges of $\pm\frac{1}{3}e$ on three balls. They further assert that fractional charges are near the surface since they can be removed by washing and can be changed by $+\frac{1}{3}e$ with an electric discharge, According to them, their experiments present evidence in favour of fractional charges because (i) no electromagnetic multiple forces can account for the fractional charges observed, (ii) all of the residual charges observed are within the experimental error of 0, $+\frac{1}{3}e$ or $-\frac{1}{3}e$, and (iii) they have modified the apparatus. All measurements under different conditions have given the results *0* and $\pm\frac{1}{3}e$. More experiments only can establish the truth.

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# Solitons—mysterious particles of nature

'I was observing the motion of a boat which was rapidly drawn along a narrow channel by a pair of horses, when the boat suddenly stopped not so the mass of water in the channel which it had put in motion, it accumulated round the prow of the vessel in a state of violent agitation, then suddenly leaving it behind, rolled forward with great velocity, assuming the form of a large, solitary elevation, a rounded smooth and well defined heap of water, which continued its course along the channel apparently without change of form or diminution of speed. I followed it on horse back and overtook it still rolling on at a rate of some 13 km or 14.50 km per hour, preserving its original figure about 90 cm long and 30 cm to 45 cm in height. Its height gradually diminished, and after a chase of one or two kilometers. I lost it in the windings of the channel.' That was how John Scott Russel, an engineer, described what is now known as a soliton. That was also the first recorded observation of a soliton made in the first half of the nineteenth century. Solitons are solitary waves that retain their shapes and velocities indefinitely and in some cases do that even after collisions with other solitons. The solitons are what is known as non-dissipative waves. To compare them with the ordinary dissipative waves one has only to consider the common example of dropping a stone into a still pond. As soon as the stone is dropped a dissipative wave is generated which gradually dies away from the source. First mathematical treatment of solitons was given by D. J. Korteweg and Hendrik de Vries in a paper published in *Philosophical Magazine* in 1895. They showed that solitons can exist due to nonlinear wave motion in hydrodynamics. The importance of solitons lies not just in hydrodynamical problems but also in many modern branches of physics. For example, two dimensional solitons appear in superconducating materials in the following way. Consider an experiment in which two superconducting metals (niobium and lead) are separated by 25 Å thick (Å stands for one Ångström unit which is equal to $10^{-8}$ centimeter) barrier layer of niobium oxide. In accordance with Josephson's theory (Brian D. Josephson, a British physicist, was awarded the Nobel Prize in 1973 in physics for discovering tunnel effects between superconductors) magnetic flux will penetrate this very thin layer. It has been found that an arbitrary number of flux quanta propagate as a wave of permanent profile. These waves are solitary waves or solitons and are described by what is known as sine-Gordon equation.

The study of solitons is also important in plasma physics, especially in plasma instabilities. Solitons are structures localised in space. Another kind of soliton, called instanton, is being presently investigated vigorously by quantum mechanics and particle physicists. Instanton is a kind of soliton localised both in space and time. In fact, they are considered as events rather than particles in quantum mechanics. It is now believed by many theoretical physicists that instantons and solitons may explain many hitherto unsolved puzzles in quantum mechanics and particle physics. For example, consider the problem of tunneling. Consider an object (Fig. 6) at rest at a point A which is situated at the bottom of a hill represented by the shaded area. According to classical physics the object cannot by itself climb the hill and go to the position of rest at B, which is also situated at the bottom of the hill but on the other side. If we just consider transition from point A to point B, energy will be conserved in this transition. This is because energy spent in climbing the hill will be compensated by the energy gained in going down the hill. This is, however, not possible in classical physics because energy will not be conserved at every point of the journey. But quantum mechanics allows this kind of transition and the process is known as tunnelling. For example in Fig. 6 A, B can be considered as ground states (i.e., states of minimum energy) or vacua of

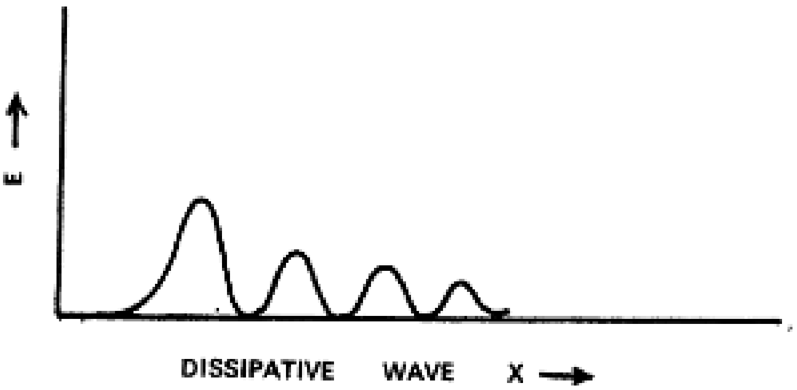

Fig. 1. Graph of a dissipative wave. Here energy is plotted against space coordinates

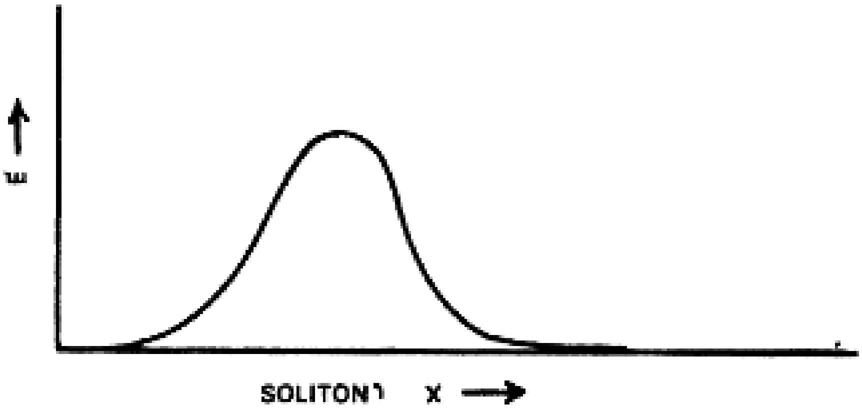

Fig. 2. Graph of a solitary wave. Here also energy is plotted against space coordinates

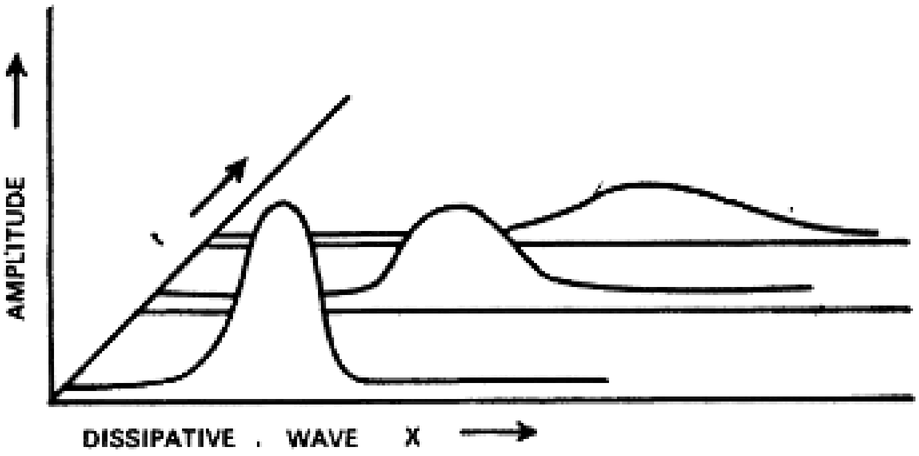

Fig. 3. A dissipative wave. Amplitude is plotted against both space and time coordinate

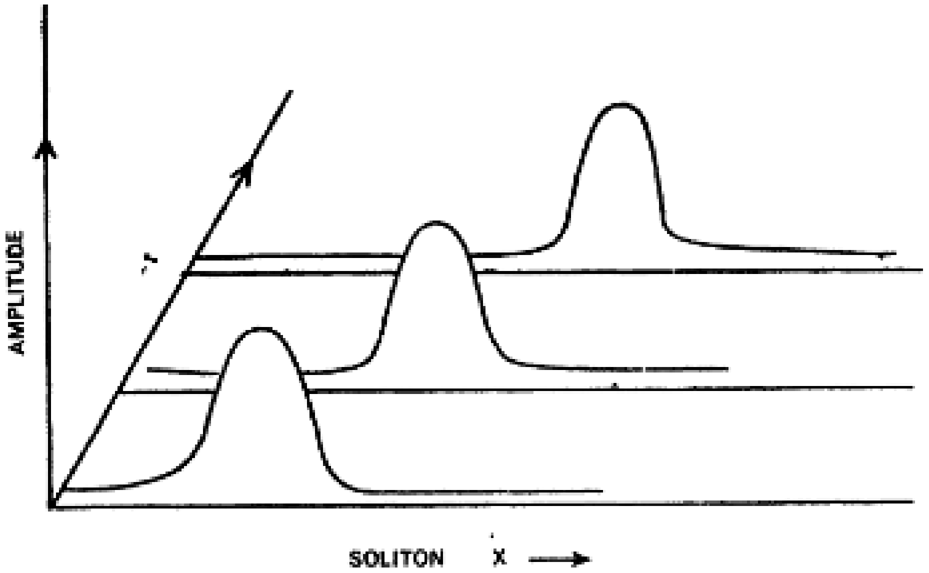

Fig. 4. Solitary wave. Amplitude plotted against both space and time coordinates

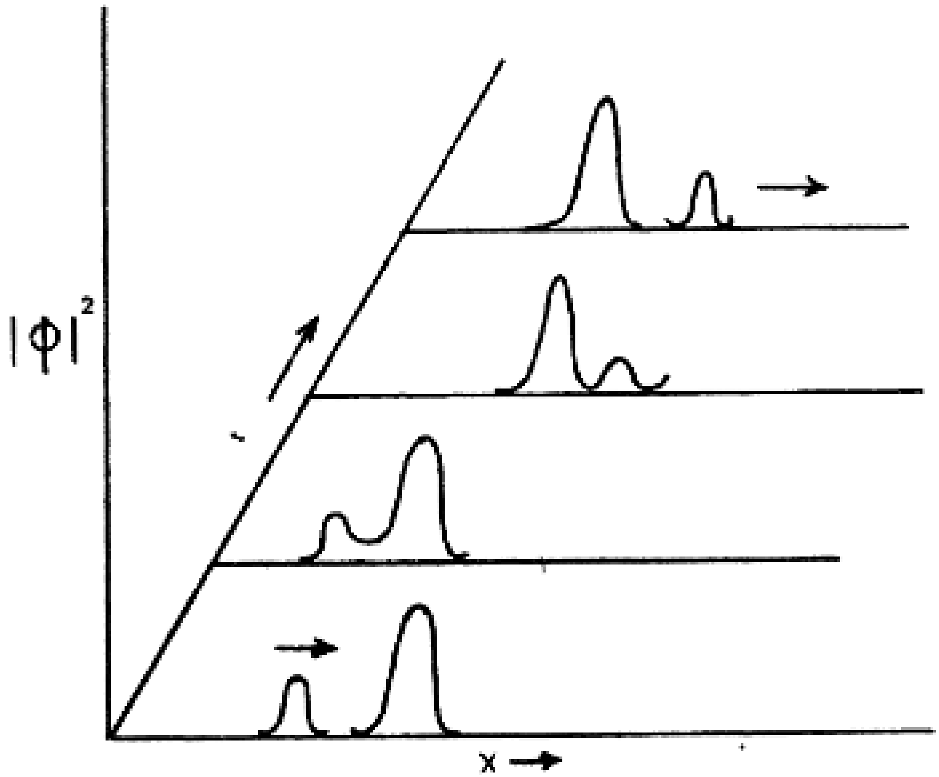

Fig. 5. Interactions of solitons with different masses. A light soliton hits a heavy one. Here square of the amplitude is plotted against both space and time coordinates

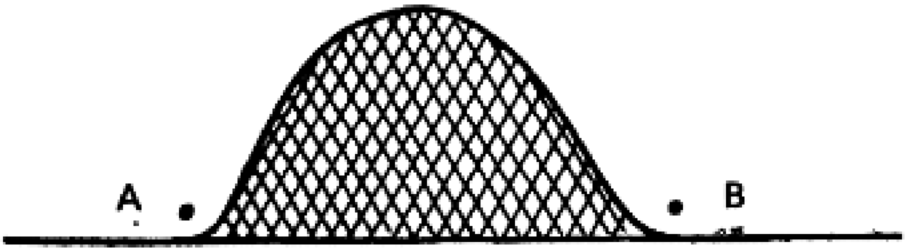

Fig. 6. A and B are two points on ground level situated on the opposite sides of the hill (shaded area)

a potential whose shape is given by the outline of the hill. These classical vacua are equivalent but distinct. But existence of instanton forces a redefinition of the vacuum. The true vacuum then must be a superposition of these two vacua. Quantum mechanical tunnelling can occur from one vacuum to another. Instantons occur as solutions of quantum field equations under certain conditions, which give rise to the possibility of quantum mechanical tunnelling. The graph of an instanton is identical to that of a soliton described by a sine-Gordon equation.

It is now known that particles which were considered elementary till a decade back are not at all elementary. They are made up of even smaller structures now known as quarks or partons. In standard quark model a pi-meson is made up of a quark and an antiquark. According to this theory there should be four mesons of equal masses. But as is well-known there are three pi-mesons ( $\pi^+$, $\pi^-$, $\pi^0$ ) The fourth light meson is yet to be found There is, however, another meson called $\eta$ (eta) meson whose mass is four times that of pi-meson, which can fit into this role. Now it is argued by some physicists that instanton can explain this rather large mass difference between $\eta$ and $\pi$ mesons.

The properties of solitons discussed above give them the status of elementary particles. But even if they exist, they would be so heavy (about 1000 times as heavy as a proton) as to escape detection by present high energy accelerators. But in not so distant a future, accelerators will be able to generate particles as heavy as, even heavier than, solitons. So only the future can tell whether solitons as particles exist in nature or they are simply brain children of clever physicists !

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# Polymer lubricants

POLYMERS and polymer composites are being increasingly used in place of metals in various industries, namely, automotive, aerospace, biomedical, computer, electrography etc. Polymer tribology is one of the new areas of polymer applications. It deals with friction, lubrication and wear of polymeric materials and answers some of the problems relating to polymer-polymer interactions or polymer-rigid body interactions. Earlier studies on friction and wear were stimulated by the growth of rubber tyre industries. Continuous research through the sixties has broadened the base to include other polymers such as nylon, polyolefins and polytetrafluoroethylene (P.T.F.E.).

The role of lubricants in machines can hardly be over-estimated. It is possible to make machine parts self-lubricating if they are made of materials of low coefficient of friction (μ) or atleast their surfaces are modified to have reduced friction. In addition to a low coefficient of friction such materials should have all the properties which their metallic counterparts have such as mechanical strength, low wear rate and thermal stability under load. The property requirement depends on where the machine part is used and the operating conditions.

One of the most common uses to which polymers have been put is in "dry bearings". For this the choice of the polymer is very important. There are two primary property requirements for dry bearings.

(i) The material must be able to support an applied load under working conditions without considerable distortion; and

(ii) Both the coefficient of friction and the wear rate should be low and insensitive to minor changes in the working conditions, viz., temperature, humidity contaminations, etc. P.T.F.E. and Nylon.-6, 6 have been found to be ideal bearing materials since they have favourable properties in terms of tensile and impact strength, moisture absorption, specific wear rate, coefficient of friction and softening point.

The surface property of both metals and polymers can be improved by suitably treating their surface. Thin layers of polymers can be coated on metal surfaces to reduce the wear as well as the coefficient of friction thus eliminating or at least reducing the use of any conventional lubricant. Among the polymers used as solid film lubricants are polycarbonates and polyimides. Polycarbonate is a potentially valuable material for abrasive or erosive wear situations. Polyimides on the other hand have outstanding temperature stability. It has also been reported that wear rate of polyimides is lower in an atmosphere of $N_2$ (by factor of 100). The wear properties of polymides can be improved by graphite additions. $MoS_2$ as an additive is ineffective in air; it is useful only for applications in space or in ultra-high vacuum.

There are two processes for producing low-friction surfaces on elastomers such as neoprene, butyl rubber and Buna N rubber. The first involves one-step graft fluorination carried out in an autoclave containing sulphur, P.T.F.E. and acrylic acid plus the rubber. The second process grafts partially fluorinated oligomers of ethyl-acrylate and acrylic acid out of the surface after swelling the rubber with suitable solvent and then irradiating with U.V. light. The grafting of P.T.F.E. and PVC on to other polymers by electron irradiation is also possible. There are reports that when glass-reinforced polymers such as phenol-formaldehyde, epoxides, etc., are used as friction couples in conjugation with steel using glycerine lubrication, boundary layers are formed on the plastic surface leading to a lowering of friction.

Recent developments in electron beam curing of polymers offer another method to locally harden surfaces. For example, polyethylene can be cross-linked in the upper few microns of surface for sliding applications. Japanese workers have tried irradiating polyethylene with γ rays from $^{60}$Co sources with doses above $10^6$ roentgens with beneficial results.

## Transfer films

When organic polymers are involved in bearing applications, the phenomenon of material transfer to or from the shaft is of major importance. Thus in the case of PTFE bearings rubbing on a steel shaft, after some time, the situation changes from one of PTFE rubbing on steel to one of PTFE with subsequent reduction of friction. Under exceptional circumstances metals can, however, transfer preferentially to the polymer, e.g., PTFE rubbing on silver, but this phenomenon is unusual and not likely to be encountered in practice.

In view of the potentially beneficial effects of transferred films, it may be possible to tailor-make bearing materials that will form semi-permanent transfer films by chemical-bonding. For example, an uncured epoxy resin could be cross-linked with pthalocyanin derivatives, which are known to produce thermosets with relatively good high-temperature properties. When allowed to wear against a steel shaft, a strongly adhering transfer film is formed by virtue of chemical complexing between nitrogen in the pthalocyanin component and the metal surface. Thus one could effectively anchor epoxide layers to the surface.

### Biomedical applications

Polymers have been used as coatings of metal surfaces for use in bone implantation for patients suffering from osteo-arthritis and for accident victims. Ultra high molecular weight polyethylene has been studied *in vivo* as a replacement of the hip joint.

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# Sexual incompatibility in higher plants

ANGIOSPERMS (flowering plants) have evolved a number of mechanisms to prevent fertilization if male gametes having proper genetic composition are not available. The most common phenomenon of this kind is failure of crosses between different plant species. There are a number of steps between pollination and actual fusion of gametes. Many steps, like pollen germination, penetration of the stigma by the pollen tube and elongation of the pollen tube through the style, depend upon mutual exchange of chemical signals between the pollen and the ovarian tissue. If the two are genetically not matched, the signals sent out by one are not received by the other. Reactions leading to fertilization do occur in a well-orchestrated manner.

But apart from the common occurrence of interspecific barriers, there also exist mechanisms that prevent fertilization within the same species. Phenomena of this nature are called incompatibility. They are governed by alleles of a gene called S. If the same allele of S is present in both the reacting partners, it acts as a barrier to fertilization. This mechanism automatically prevents self-fertilization and helps individuals in maintaining their heterozygous nature. In a review published recently on this subject (*Naturwiss. Rundschau*, 33, 11-20, 1980), Prof. Hans Ferdinand Linskens of Nijmegen (Holland) stated that incompatibility had so far been discovered in about 3000 species of Angiosperms representing almost 50 different families.

Depending upon the stage at which incompatibility manifests itself the phenomena are classified into sporophytic or gametophytic incompatibility. The pollen of a plant is technically a male spore Therefore, if incompatibility mechanism inhibits pollen germination or the stages immediately following germination it is called sporophytic incompatibility. It occurs exclusively in the case of species having trinucleate pollen grains. In such species, the rate of respiration of pollen grains is very high during their development and it is assumed that because of the high rate of metabolism, the pollen is depleted of some essential nutrient components which have to be supplied by the ovarian tissue before the steps leading to fertilization can be taken.

The actual mechanism of inhibition or promotion of pollen germination is governed by an interaction between a layer of a specific protein on the stigmatic surface and certain substances occurring in the outer wall or exine of the pollen The exine substances react with the protein film of the stigma and, depending upon the feedback signals received by the pollen, its germination is either triggered or inhibited. The process of germination is also accompanied by secretion of a cutinase enzyme which dissolves the stigmatic cutin leading to the penetration of the stigma by the pollen tube

Incompatibility of this type, reported in the case of many species belonging to the families Cruciferae, Papillionaceae and Compositae, can often be artificially overcome by placing pollen directly on the stump of a style of which the stigma has been mechanically removed. Another method of achieving fertilization in such cases is by pollinating immature flowers, because incompatibility mechanism often develops at a later stage.

Mechanisms that arrest steps following pollen germination are grouped under the term gametophytic incompatibility, because a germinated pollen grain represents male gametophyte of plants. Incompatibility of this type is mainly observed in species having binucleate pollen. In the case of many species of the family Solanaceae and also in the genera *Trifolium* and *Abutilon*, the growth of pollen tubes through the style is arrested if the pollen grains happen to possess the same allele of S as the ovarian tissue. In several representatives of the family Liliaceae, the pollen tubes grow unhindered through a hollow canal running along the centre of the style so that incompatibility appears at the last stage, namely, at the stage of gametic fusion.

The fact has already been mentioned that mechanism of incompatibility was primarily evolved by plants to avoid self fertilization But such a mechanism also carries with it the inherent risk of failure of seed setting, if cross-pollination were to fail. In the case of grasses, which often show a high degree of cross-pollination, the pollen are carried by wind. Wind is generally always present in nature, but under certain weather conditions like continuous rains or foggy atmosphere, the pollen are either washed off or not shed at all. In the case of many dicotyledons, where honeybees or other insect pollinators are required for cross-pollination, the seed set may be seriously hampered if the insect population is depleted due to excessive use of pesticides or some other environmental causes In order to avoid this risk, some plants seem to have evolved a compromise called selective fertilization In it, pollen grains having a certain genotype stand a greater chance of fertilizing the ovule than other pollen grains But if the preferable pollen types are not available, self-fertilization is allowed to occur so that some seed is always produced

The preference mechanism acts at the stage of pollen tube growth through the style The growth of a pollen tube towards an ovule has been shown to be a chemotropic reaction The chemotropically active substances responsible for this reaction are relatively simple compounds like amino acids sugars and peptides Depending upon its genotype, the ovarian tissue produces these substances in varying amounts Because the sensitivity of the pollen to these substances is also genetically determined, pollen tubes show different rates of growth through the style, depending upon the concentration of the various chemotropically active substances in the ovarian tissue. This mechanism does not arrest pollen tube growth of certain genotypes as in the case of incompatibility, but only changes the rates of growth so that tubes of the plant's own pollen grow slowly while those of pollen from other individuals grow at a faster rate. Because the faster growing tubes reach ovules earlier, chances of the ovule being fertilized by such pollen are increased If however pollen from other individuals are not available, ovules are eventually fertilized by the slower growing, self-pollen

Because seed is always developed in such plants, whether the flower receives its own or outside pollen, it is often difficult to detect the presence of this mechanism in a plant But systematic experiments, using mixtures of pollen grains from different origin, have shown that preference to foreign pollen over one's own pollen is a phenomenon occurring in a very large number of plants

There is now evidence to show that mechanism of selective fertilisation can act even through the selection of female gamete During the formation of the female gamete, the diploid embryo-sack mother nucleus undergoes a reduction division to form four haploid daughter nuclei, out of which the one nearest to the chalazal end survives to form the embryo-sack, while the remaining three nuclei degenerate. According to Linskens, it is often the genotype of a daughter nucleus that determines the pole to which it would migrate during meiosis, determining thereby the genotype of the future female gamete

The presence of gametic selection at the stage of female gametogenesis is accompanied by a peculiar phenomenon. It is a well-known fact that an $F_2$ generation shows Mendelian segregation of characters with its typical ratios of 1 2:1, 9·3:3 1, etc However, one of the basic requirements of Mendelian genetics is a random mating of individuals, in which all gametes have equal chance of fusion But in plants, in which only one genotype is allowed to form female gametes, segregating $F_2$ populations fail to show the typical Mendelian ratios of segregation

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# Nickel—an essential trace element

NICKEL is a well-known transition metal It is an essential element for the smooth functioning of our body system. Nickel is present in microgram quantities in the tissues of human body.There are approximately 10 mg of nickle present in a normal man, with wide individual variations Wheat, rice, vegetables etc contain nickel which meet the daily requirement of our body system.

A Schnegg and M. Kirchgessner, of the Institute fur Ernahrungsphysiologie , Technishe Universitat Munchen, West Germany, have demonstrated the nutritional necessity of nickel They have produced nickel deficiency in rats associated with retarded growth. The nickel deficiency caused reduction in hemoglobin concenration and hematocrit (the volume percentage of erythrocytes in whole blood). The erythrocyte (red blood cells) counts were also found to be retarded. They have further shown that nickel deprivation impairs absorption of iron by intestines which causes anemia

M. Anke, *et al* of the Karl Marx University, East Germany, have demonstrated that nickel deficiency results in reduced pregnancy rates which caused delayed pregnancies and birth of offspring. Nickel deficiency results in reduced birth weights and also lower weight gains during suckling period.

Nickle deficiency in growing rats caused decrease in the enzymatic activities of glucose-6-phosphate dehydrogenase, malate dehydrogenase isocitric dehydrogenase, lactic dehydrogenase, L-hydroxy butyrate dehydrogenase, glutamate dehydrogenase, glutamate oxalacetate transaminase and glutamate pyruvate transaminase in rat hepatocytes The activities of glutamate dehydrogenase, glutamate oxalacetate transaminase and of glutamate pyruvate transaminase was found to be decreased in kidney as a result of nickel deficiency

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# H-Y antigen genes location

HISTOCOMPATIBILITY-Y (H Y factor) is a male cell surface component—a product of mammalian testis-determining gene (*S R*, Dec 1978, p 828) Detected as H-Y antigen, it is known to direct the differentiation of the bipotential (indifferent) embryonic gonad to testis (male), its absence leads to the formation of ovary (female) H-Y antigen was first recorded in 1955 by F I Eichwald and C R Silmser (U S A ) during their studies on skin grafts. Later, several scientists showed that this antigen is implicated in sex-determination of mammals including man In 1966, M C Bunker (Canada), indicated the locus of this gene to be on the Y-chromosome Five years later, K D Simpson (U.S.A ) concluded from his studies that there are two H-Y gene loci, both near the centromere of Y-chromosome, one on the short arm (p) and the other on the long arm (q) Recent works of J M Rary, D. K. Cummings, H. W Jones (Jr.) and J. A. Rock (Department of Gynecology and Obstetrics, Eastern Virginia Medical School Norfolk and Johns Hoppkins University School of Medicine, Baltimore USA *Jour Hered* 70 : 78 80 1979), however strongly indicate that there is only one locus for H-Y gene and that it is on the short arm of Y chromosome

Using sperm cytotoxicity technique to determine the presence or absence of H-Y antigen, Rary *et al* studied two patients one a five-day old patient with 46, X i (Yp) (46 autosomes+1 X-chromosome +1 isochromosome of Y involving short arm) and the other, a ten year-old patient with 46, X,i (Yq) (46 autosomes+1 X-chromosome +1 isochromosome of Y involving long arm) They used fibroblast and/or leucocyte cultures for metaphase chromosome preparations using standard techniques Fluorescent quinacrine banded karyotypes of the 5 day-old infant with isochromosome for short arm of Y prepared from leucocyte cultures, showed a mixture of 46, X i (Yp) and 46, X (a mosaic), nearly 60 per cent leucocytes showing the 46, X, i (Yp) condition Fibroblast cultures (skin biopsy) of the same patient, however, showed only 46, X i (Yp) karyotype. The other patient with isochromosome for the long arm of Y, on the other hand, uniformly showed 46, X i (Yq) karyotype in the leucocyte as well as fibroblast cultures from skin and streak gonads Sperm toxicity tests carried out on the 46, X, i, (Yq) patients were H Y antigen negative, while ) the tests on the 46, X, i (Yp) patient were double positive (because) of the double dose of short arm and hence two H-Y antigen genes) This male specific antigen was also found to absorb more H-Y antibody in XYY individuals (males with one extra Y chromosome, Y trisomy) compared to XY individuals (normal males) The presence of double amount of H Y antigen in the fibroblast from an individual with 46, X i (Yp) chromosomal constitution, according to these scientists, is an almost conclusive proof that the H-Y antigen gene is located on the short arm of the Y-chromosome

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# Synthesising common bread wheat varieties

WE know that the present day plants and animals have evolved from their primitive ancestral stocks Of special interest are the plants and animals that have played a significant role in the man's economy. Knowledge of the primitive ancestor(s) helps breeders plan their experiments with a view to introducing useful traits (genes) into the genetic constitution of cultivars. Breeding through genetic manipulations for quantity, quality, resistance to diseases, insects, pests, drought, etc., ultimately leads to increased yield of a crop. By shuffling genes responsible for these traits, breeders try to obtain the best possible combination(s) through breeding cultivars with their wild relatives, variable number of back-crosses and selection. Immediate wild ancestors, if available, present a large gene-pool to have a wide choice for selection. While there are some cultivated plants whose immediate ancestors have become extinct long ago (e.g., maize) leaving a large gap between them and their wild ancestors, there are others where a clear and closer link between the present day plants and their kith and kin is shown, so much so, that by proper breeding experiments even the present day plants can be synthesised (e.g., cotton, tobacco, etc.)

Moshe Feldman (Weizmann Institute of Science, Israel) has recently been able to identify the 'missing link' in the evolution of present day wheats (*Scientific American*, **240(2)**, :59-60, 1979). One of the major cereal crops of the world, common bread wheat is a polyploid (having multiple sets of chromosomes) and a chromosomal mixture of closely related progenitor species. All bread wheats are hexaploids (2n= 42, six chromosomal sets each with seven chromosomes) and contain three genomes : A, B and D derived from three primitive wheat species. Genome A has come from *Triticum monococcum*, D is from *Triticum tauchii* and the genome B is from an unknown species which got extinct about 10,000 years ago.

Feldman, while a graduate student at Hebrew University, Jerusalem in early 1960's recorded a strange-looking wild wheat plant and tentatively identified it as *Triticum longissimum*. He found the same type of plant again in 1972. On closer examination, he had doubts about the validity of its name. Later, having collaborated with a taxonomist (Mordechai Kisler of Bar-Ilan University) the plant showed clear morphological differences from *Triticum longissimum*, as speculated. The new plant also showed chromosomal differences (through studies on karyotype analysis) and was given a new name, *Triticum searsii* (after the pioneer wheat geneticist E. R. Sears of the University of Missouri).

One chromosome set of *Triticum searsii* is virtually found to be identical with the B genome in *Triticum dicoccoides* (another wild species of wheat containing A and B genomes) and also bread wheats (that have A, B and D genomes). That *Triticum searsii* has contributed B genome to the bread wheat is also further proved through biochemical studies (a few years ago, many wheat cytogeneticists had hastily accepted *Triticum speltoides* as the donor of B genome).

The B genome in wheat is of great significance to breeders because it carries harmful gene that suppresses pairing and crossing over (exchange of non-sister segments between homologous chromosomes), thereby inhibiting recombination. This antipairing trait has greatly complicated the transfer of genetic information by cross-breeding. Feldman is searching for individuals of *Triticum searsii* in which this antipairing trait is either weak or absent. This will aid in the production of new varieties. Feldman is also artificially synthesising the present day bread wheat by using *Triticum monococcum*, *Triticum searsii* and *Triticum tauschii* (contributors of A, B and D genomes, respectively) as the raw materials. While he has succeeded in combining A and B genomes, attempts to add D genome are being made. Through genetic manipulation, several desirable genes from the wild ancestors of wheat, in this process, can be easily transferred on to the commercial varieties of bread wheat.

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# Plant protoplast culture —a new dimension in plant research

PLANT tissue and cell culture is comparatively a recent technique. In 1902, Haberlandt for the first time clearly emphasised the need of plant tissue culture, that would provide some insight into the properties and potentialities, which the cell possesses as an elementary organism. It would also give information about the interrelationships and complementary influences, to which cells within the multicellular whole organism are exposed. Complexity is one of the characteristics of higher plants and as a result, it poses problems to the workers concerned with plant biochemistry and physiology. Tissue culture and cell culture is a promising technique to face this problem, which reduces the complexity by isolating particular organ or tissue and culturing it on a suitable medium in aseptic conditions.

Plant scientists made an intelligent attempt to remove the wall of the plant cell (which acts as a barrier to foreign materials) and culture these naked protoplasts on suitable medium This is protoplast culture. Though exploitation of cell and protoplast culture techniques for purely scientific purposes is still in its infancy, its commercial implications were already established. From the practical point of view, protoplast culture is most exciting, since it appears to offer for artificial genetic manipulation, protoplast fusion (somatic hybridization) and gene transfer that will yield new revolutionary varieties of crop plants, which is impossible with walled cells.

### What is a protoplast ?

The isolated plant protoplast is limited by plasmalemma and in its initial stages, contains all the cell components except the cell wall. But in fact, it is not so from the physiological point of view, since the techniques involved in isolation of protoplast in association with the environmental factors undoubtedly influence the metabolism and ultrastructure of the newly formed protoplast. The selective permeability of the cell may be affected with the loss of wall and the protoplast, as a result, shows leakage of solutes. Another property of the newly formed protoplast is that irrespective of the immediate cultural environment, the protoplast starts synthesising the lost cell wall. This property of the protoplast is unique for somatic hybridization, gene manipulation and gene transfer.

### Preparation of protoplasts

Isolation of plant protoplasts can be traced back to Klerker (1892) and Kuster (1940), involving plasmolysing the cells and subsequent cutting of walls to release protoplasts during deplasmolysis. In 1960, Cocking introduced a comparatively successful method using cell wall degrading enzymes. Protoplasts can be obtained either directly from the whole plant or indirectly from *in vitro* cultured tissues. Cocking and Power (1970) suggested the use of a mixture of Pectinase and Cellulase enzymes to plant tissue which macerate the cells and at the same time destroy their walls. In the same year (1970) Nagata and Takebe introduced a two step sequential procedure to obtain protoplasts. They suggested the production of single isolated cells prior to cellulase treatment. Most common enzymes used in the process are purified preparations of cellulases, hemi-cellulases and pectinases of fungal origin. Isolation of protoplasts may be done from the various tissues like callus suspension cells, pollen, leaves, fruit plasenta and tumor tissue.

Loss of cell wall causes the newly formed protoplast to burst at any time. So they should be stabilized and maintained in a hypertonic plasmolyticum which is often 13% mannitol. Mannitol, since easily transported across the plasmodesmata, provides a stable osmotic environment for the protoplasts.

### Role of protoplasts in plant physiology

When growth promoters like IAA are applied to plants, they act directly on plasmalemma of the cell and increase the permeability of the membrane to water resulting in cell elongation. This can be established by the use of protoplasts *in vitro*. When IAA is applied to the plasmolyticum containing protoplasts, they expand rapidly and finally burst due to too much vacuolation (Cocking and Hall, 1974). Further it can be verified by using antiauxins that suppress this bursting, indicating that the site of action of IAA is the plasmalemma of the plant cell. In the same way the site of action of 'Paraquat' can also be proved. Paraquat is a herbicide which disrupts plasmalemma and collapses the protoplast. Thus the site of action of Paraquat is the plasmalemma itself.

### Use of uptaking property of plant protoplasts

Newly released protoplasts show high pinocytic activity. This property stimulated many scientists to introduce foreign particles into protoplast which are biologically active, so that a modified cell can be achieved after the regeneration of its cell wall. Foreign particles may be macromolecules like ferritin, polystyrene latex particles or DNA (Wilhson, Grout and Cocking, 1971); cell organelles like chloroplasts or nuclei (Potrykus, 1975); symbiotic organisms like some algae, bacteria or virus (Davey and Power, 1975, Bonnett and Eriksson, 1974). Davey and Cocking claimed that nitrogen fixing bacteria (Rhizobium) could be entered into pea leaf protoplasts in the process of isolation. But the expression of this bacteria in the plant cell is still not reported. These procedures may be more advangeous to plant breeder in getting more efficient crop varieties in near future.

The plant-virus interrelationships in the past were not clearly known due to the lack of suitable experimental systems, that can easily infect the cells. But after the innovation of protoplast isolation and its culture, this problem is almost solved. Protoplasts can directly be inoculated with pathogenic virus in the medium and their effects can be studied in detail with relative ease. Isolated plant protoplasts further opened vistas for certain biochemical studies with special reference to photosynthesis (Edwards, Huber & Gutierrz, 1976).

One of the exciting and potential properties of protoplasts is that each isolated protoplast is entirely separated from another and hence a population of protoplasts provides the best possible approach to a single isolated cell system. This permits the handling of protoplasts in much the same way as with micro-organisms. Takebe (1975) successfully exploited this property for synchronous infection of protoplasts by virus.

### Somatic hybridization

The potentiality of isolated protoplasts to give entire plants together with the ability of their fusion and forming hybrid cells open the possibility of producing hybrid plants by somatic hybridization. But there are many problems involved during the recovery of viable hybrid cells, like failure of the nuclei to fuse, loss of chromosomes due to difference in their replication times, difference in position of the cell cycle of fusing protoplasts resulting in premature condensation of chromosomes. Some of these difficulties were discussed by Power, Freason, Hayward and Cocking (1975). To overcome these obstacles, rigorous selection involving even millions of colonies of parent protoplasts is necessary

For the first time, in 1972 Carlson Smith and Dearing reported a somatic hybrid in higher plants involving two different sexually compatible species of *Nicotiana*, using mesophyll protoplasts (*N glauca* × *N longsdorffii*) Recently somatic hybrids between *Petunia hybrida* and *P parodii* have been recovered by Power, Freason, Hayward, George, Evans Bery and Cocking (1976).

Generally, the protoplasts do not fuse except those derived from microsporocytes One of the reasons why they may not be so is that the surface of protoplasts carry a charge and so there will be strong tendency to repel one another Under normal conditions this charge is negative. Further Poste and Allison (1973) suggested that fusion takes place when the molecular distance between the protoplasts is $1\ m\mu$ or less. This indicates that protoplast fusion is highly a traumatic event. To overcome this, we can use some fusion inducing agents in the medium. Power, Cummins and Cocking (1970) reported such substance for the first time, as Sodium nitrate. Binding (1974a) suggested that alkaline conditions together with calcium salts favour fusion, but subsequently decrease the viability of the fusion products. Most recently suggested fusing agent is PEG (Polyethylene Glycol), which causes dramatic aggregation of protoplasts (Kao and Michayluk, 1974; Walchin Glimmelius and Eriksson, 1974).

### Culture

The object of culturing isolated protoplasts or their fusion products is to promote wall synthesis, regeneration, subsequent cell division and finally to exploit the inherent growth and developmental potential of these regenerated cells to recover entire plants. The basic nutritional requirements of isolated protoplasts or their fusion products are similar to those of the cultured cells. In addition to these, an osmotic stabilizer must be present in the medium to stabilize and maintain the protoplasts (against bursting). Following development of protoplasts into whole plants, in case of fusion products the resulting cytoplasmic hybrids are known as 'cybrids' In fact the frequency of true hybrid cell formation is $10^{-6}$, which is very low

One must conclude that inspite of the undoubted proof that somatic hybridization is possible, its potentiality for crop improvement is fully realized when this technique is extended successfully to truly sexually incompatible species

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# Why does *boro* rice require longer duration for maturity?

IT is a common experience with the agriculturists that the rice cultivars require longer duration for maturity under *boro* culture (December-May) than *kharif* culture (June-October). The major environmental components accounting for variation between the two seasons are the differences in photo- and thermo-periods. Since the cultivars, which are grown in both the seasons, are essentially photo-insensitive, the thermo-period is considered to be mainly responsible for the delaying of maturity duration in *boro* season. In north eastern India the *boro* cultivars are generally sown in December and harvested in May. Temperature during substantial part of this period is low, generally ranging between 10°C and 18°C. Scientists are of the opinion that this range of temperature retards the normal growth of the rice seedling and consequently results in delayed maturity.

### The nature of low temperature damage

A Japanese scientist Kaneda and an American scientist Beachell (1974), in an excellent review on low tem-

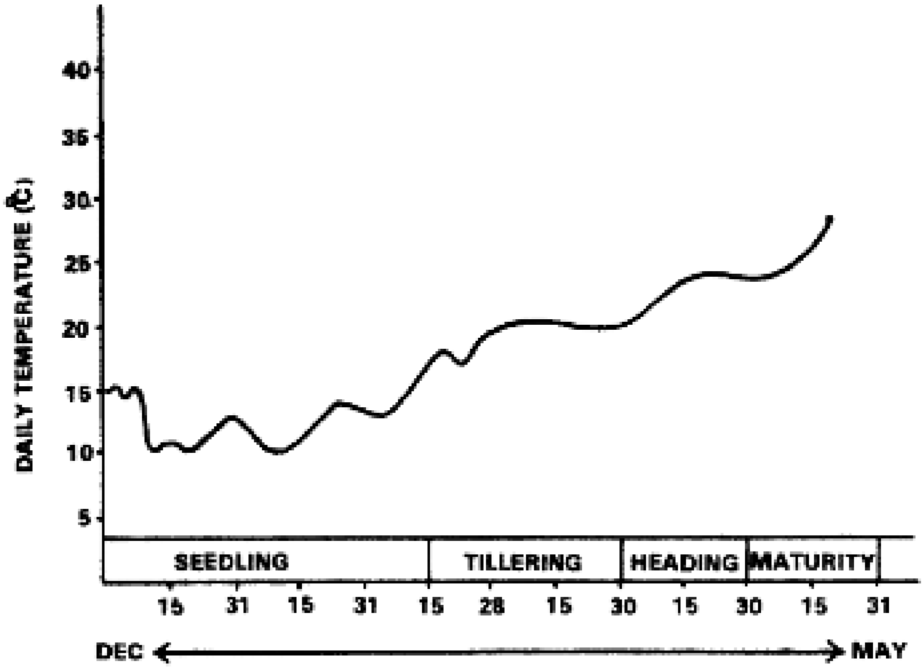

Fig. 1. Temperature changes faced by the rice plant at different stages of growth in boro season (North-Eastern India)

perature crop damage, have mentioned the following types of cold injury:

(i) low germination in seed bed or in direct seeded field, (ii) slow development of seedling, (iii) stunting of plant accompanied by increased or decreased tiller number, (iv) leaf discoloration in early vegetative growth stages, (v) degeneration of panicle tip, (vi) prolonged growth duration, (vii) sterility, (viii) irregular maturity of grains, and (ix) irregular heading within hills.

In north-eastern India, however, low temperature prevails only during the early vegetative growth phase of the *boro* culture (Fig. 1) and accordingly the following types of low temperature damage have been identified:

(a) failure of or prolonged duration for germination, (b) occasional yellowing of seedling, (c) stunted seedling growth, and (d) prolonged leafing interval.

Of the above mentioned damages, the last two effects are the consequence of slow crop growth rate and are directly related to delay in crop maturity.

## How growth is checked

Available literature on this subject in India and abroad suggests that a temperature below 15°C results in inactivation of the leaf amylase of the rice seedling Amylase is an enzyme which splits starch into simpler forms for its utilization by the plants. Starch is accumulated in the leave during the day time At normal temperature this starch disappears overnight, but most of the starch under low temperature condition is unutilized and accumulates in the chloroplast of the plant. The retention of starch granules consequently results in reduction of dry matter production and thereby causes slow growth rate of the seedling.

## Solution : a plant tailoring design

It has been reported by the scientists of the Crop Breeding Research Unit of Calcutta University, College of Agriculture and also by others that rice varieties accustomed to growing in a low temperature prevailing region have certain characteristic features for continuation of normal growth under such condition, viz.

Plant breeders are currently engaged in incorporating these characteristics into our high yielding cultivars to enable early emergence of rice panicle under *boro* conditiod of culture.

1. thick mesophyll layer, 2. large air cavity, 3. higher number of bulli form cells, and 4. reduced size of central vascular bundle.

A thick mesophyll layer acts as a protective layer and saves the cellular organelles from low temperature damage. As regards other characteristics, no satisfactory reasoning has yet been obtained.

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# Peach—a common fruit of the hills

PEACH is one of the most important stone fruits of the hilly tracts of India It is grown in large quantities in Kashmir, Himachal Pradesh, submontane tracts of Punjab and U.P. and to a limited extent in the Nilgiries in South India. Its cultivation has been started in north eastern region

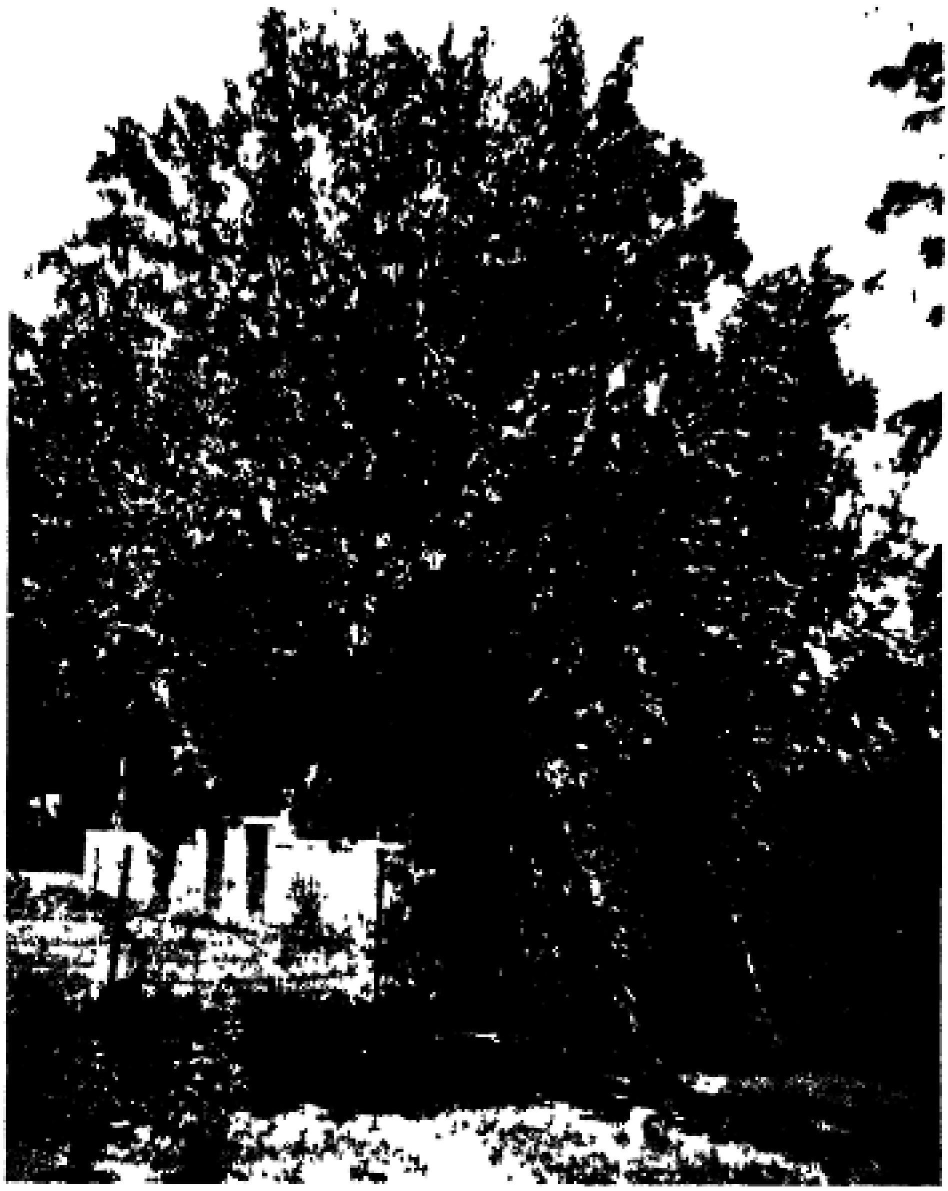

Fig. 1. Peach tree

like Meghalaya, Assam, Manipur, Arunachal Pradesh etc Recently its cultivation has been extended to a limited extent in the plains also Of all the temperate fruits, peach has the least chilling requirements; however, peach types of high quality and better taste thrives well in the mild hilly areas

Botanically the plant is named *Prunus persica* Batsch and belongs to the family Rosaceae. Locally it is called Aru. The plant is believed to be a native of China where a related species *Prunus davidiana* is still growing wild. It is considered to have been introduced to the west by way of Persia which for some time was believed to be the country of origin. Peaches are grown in most part of the temperate regions of the world The major producer is the U.S.A., where it ranks second only to the apple in commercial importance. Other important countries that produce peach in large quantities are Italy, France, Spain, China, Japan, Argentina, Australia and South Africa.

It is a small tree upto 8m high with glabrous twigs (Fig. 1). Peaches bear on the previous year's growth, so the tree is regularly pruned. But unfortunately, it is a common observation that pruning is rarely practised in the private compounds except in the orchards. As a result formation of new growth is checked. This affects regular bearing resulting in significant loss of the productivity of the tree as well as quality of fruits.

Peaches are usually propagated by budding on seedling peach stock. This is a special kind of vegetative propagation where a small piece of bark containing a single bud of a desirable tree is grafted on a root stock. Ultimately both the parts unite and behave as a single tree. Generally two year old seedlings are used as rootstocks. Peach seeds take a long time to germinate Sometimes it becomes necessary to crack open the hard shell of the fruits and plant the Kernel in order to obtain quicker germination.

## Varieties

Peach has many varieties and forms A certain peach from China is said to have fruits weiging as much as 450 gm. In India there are forms with early and late ripening, nearly round or elongated shape, tastes sour or sweet etc. About 162 varieties of peach have been collected for different research studies in India, of which a dozen have been recommended for cultivation in the last Temperate Fruit Research Workshop held at Chaubattia during November 1976 (*Indian Horticulture*, Vol. 23, No. 2, 1978). Among the important types grown in India are . *Alexander*, *Pererine*, *Duke of York*, *Babcock*, *Elberta*, *Honey* etc. All these varieties have been introduced from abroad. Recently some low chilling varieties have also been introduced from Florida, U.S.A. These are *Flordasun*, *Sunred—Nectarine*, *Flordared*, *Flordabelle* etc.

## Disease

Peach is generally infected by a fungus called *Taphrina deformans* producing the peach leaf curl disease.

Fig. 2. Peach leaves and fruits

It is the most serious disease of peaches. The organism is usually confined to current year's growth and infect the leaves, blossom and twigs For its control sprays of lime sulphur 1:15 before bud burst and 1:40 after full blossom is recommended Peach leaf curling aphid, *Brachycaudus helichrysi* Kalt, is also a serious pest of peach For its control pre-blossom sprays of insecticides like methyl parathion 0.025 per cent have been found most effective.

**Uses**

Peach is a favourite table fruit (Fig. 2), but being highly perishable are difficult to transport and store It is because of this that the fruit is generally consumed by the local people of the growing regions Furthermore the Freestone (where stone gets separated) peaches are soft and juicy when ripe, so mostly are used as dessert Clingstone (where stone does not separate) peaches are hard fleshed, large and almost inedible in the raw state, but become delicious when cooked in syrup These are mostly used for canning Peaches contain a large amount of sugar, thiamine and ascorbic acid, some types contain appreciable amount of vitamin A The acids present in peach are mainly malic and citric The peach pits which are available in considerable amount in the canning industries find limited use for fuel purposes or in poultry feeds The timber of the tree is used as fuel and can also be used for building and other purposes

Peach flowers are also very beautiful Flower colour ranges from light orange to bright red In February-March when the tree blossoms, it is excellent to look at The whole tree is leafless and full of flowers There are varieties that are planted for ornamental purposes only as their fruits are not of good quality

**Research**

The chromosome number of peach is $2n = 16$ It has been hybridized with the Plum (*Prunus domestica*) and Almond (*Prunus amygdalus*) But the hybrids have been found to be sterile However, these can be used as rootstock to peach in budding Improvement work is in progress in different fruit breeding stations in India to evolve new types able to meet various requirements such as resistance to cold, low winter chilling requirement, processing qualities and higher fruit quality with regard to size, firmness, taste, flavour and appearance Also because of poor colouration at the time of ripening peach does not fetch good price to the growers Recently it has been found that Ethephon, chemically known as 2-chloroethyl phosphoric acid, can enhance the fruit maturity and colour development in peach (*Indian Horticulture*, Vol 23, No 1, 1978) As peach rots very quickly research is also going on to evolve some varieties that would be able to withstand transportation In near future, peach promises to be a favourite fruit of the common people and at the same time profitable to the growers also

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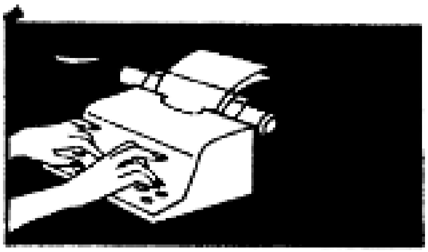

## NEWS & NOTES

# Meeting on Plan Frame for Science & Technology 1980-85

THE Draft Document on Plan Frame for Science and Technology for 1980-1985 was discussed at a meeting of scientists, planners and administrators in New Delhi on 2-3 August 1980. Addressing the gathering the Prime Minister Smt. Indira Gandhi said:

"I am glad to have the opportunity of participating in this meeting of scientists and technologists to discuss the Plan Frame for Science and Technology.

"The architect of our planning, Jawaharlal Nehru, irrevocably committed our nation to science. In the opening chapter of the Third Plan which he wrote himself, he set out the social objectives of India and the integral part of science in their realization.

'The more immediate problem is to combat the causes of poverty, with all the ills that it produces, and it is recognized that this can only be done by social and economic advance, so as to build up a technologically mature society and a social order which offers equal opportunities to all citizens. It involves not only the acceptance of the temper and application of science and modern technology, but also far reaching changes in social customs and institutions.'

"Are these words not equally relevant for our Sixth Plan? To me, science is not just an incidental concomitant or product of planning. It is at the very core of development. It is often said that the political will is the prime mover of progress. But all the will in the world cannot produce results if it is not yoked to science and technological and administrative capability.

"In the last couple of decades, Indian science has made visible headway. The world now knows that—thanks to the technological capability we have built up—India can achieve whatever goal she sets for herself. We are at a stage when this capability, which is still rather uneven, has to be consolidated. Correct decisions have to be taken now so that the process of change is faster and surer in the immediate future.

"Science must help us to speedily improve production. It would show how the latent natural and human resources can be profitably developed and equitably shared. It should help us create more employment and reduce drudgery. It should strengthen the nation and reduce our vulnerability. It should make our society hardier and more resilient. Besides these material goals, we look to science to eradicate old irrational attitudes which hold the nation back from its true greatness.

"Hence a sound Science and Technology Plan is a crucial segment of the general Plan. We initiated this task some years ago. I hope that as a result of your discussions at this meeting, the S & T component of the 1980-85 Plan will become more purposive and practical in terms of results.

"Self-reliance must be at the heart of S&T planning. There can be no other strategy for a country of our size and endowments. While we all readily pay obeisance to this concept, there are too many and too frequent lapses. There are reasons. It is an axiom of modern technology that the late starter cannot catch up. And India was a late starter. By the time we reach any milestone, we find the competitors have moved far ahead. At some bends in the race we might be able to take a couple of shortcuts and leap over some intermediate stages. But the advanced nations rarely give up their advantages. Last month we became the sixth nation in the world to acquire satellite launching capacity. Yet we could claim only that our technology was just a little more sophisticated than that of other nations when they launched their "early birds". While we set about building indigenous R & D, with all its attendant uncertainties in terms of performance, practised hands can offer us more advanced technology. Considerations like security, the time factor, performance guarantee and costs, often compel us to buy advanced technology from the international market. But in the ultimate analysis, neither true defence nor true development can be bought or borrowed. We have to grow them ourselves.

"So it is imperative for us to make every kind of necessary investment in ensuring self-reliant development. Alongside a few urgent and inescapable needs for which we have to import technology, programmes should be worked out to assimilate it, so that we obviate repetitive import at the earliest. In order to ensure this, we should associate R & D experts to a greater degree in the work of project assessment and import decisions.

"Indigenous results of research must be integrated with the development process and kept in mind while deciding on the import of technology and on choices for industry. Fiscal policies should be so evolved as to encourage the utilization of the results of research and indigenous capabilities, rather than supporting indiscriminate import of technology or goods. Further, a conscious effort should be made by all major ministries and organizations to establish an effective interface with the scientific and technological community.

"There is a widely current belief that Indian science has not yielded results commensurate with investment. Some of this criticism is based on ignorance, and on our national pastime of playing up shortcomings while ignoring achievements. Yet I know that many scientists feel that they could do much better if there was a clearer definition of tasks and less bureaucratisation. I hope that every organization and every scientist will make a determined effort to find answers rather than alibis. Indian science can do it. And I am sure that you will vindicate this confidence whether it be in agricultural production or in energy fuels and metals, in communications or in the improvement of health.

"In apportioning our scarce resources, we determine our priorities. Thus, atomic energy, electronics and space got their fair share of resources because of their far-reaching significance in promoting development and self-reliance. We must now make urgent and all out scientific effort to promote the development and utilization of solar and other forms of renewable energy to reduce our dependence on fossil fuels and to help safeguard our environment. Swift scientific action is also needed in regard to our marine and sea-bed resources. The scientific community must give a lead in these matters. We shall not be wanting in the response or the matching administrative action.

"I agree with many of the points made in your Draft Document, especially in relation to food, forestry, nutrition, population stabilization and energy. I endorse, in particular, the statement that science and technology have a role to play in accomplishing Plan targets at minimum cost and maximum benefit. You are also right in drawing attention to the gestation period involved in science and technology. What we are using now was discovered some time ago. If we care about the future, we should give the required thrust to S & T here and now."

Earlier, in his opening remarks, Prof. S. Nurul Hasan, Vice-President, CSIR, said, the document, Plan Frame for Science and Technology 1980-85 represents the consensus of the suggestions he received in course of his discussions with distinguished scientists, industrialists and managers of industry, documents which they sent and ideas which they communicated in their letters.

"These suggestions were given in the context of our basic national goals, namely the removal of poverty, ensuring the security and integration of the nation, and the achievement of self-reliance. Effort has, therefore, been made to ensure that the S & T Plan becomes an integral part of the various components of the National Plan.

"It is felt that major effort be made to further develop our educational infrastructure which was nearly crippled during the period of the last government, particularly in the areas of higher education and research. Considerable financial support would be required to put it back on its feet, to ensure that the training of manpower in science and technology is improved and that basic research in a number of areas, including those which are emerging only now, is given full support.

"It was also emphasized that the teaching of science and mathematics at the school stage is given special attention and that vocational education at the plus two stage is developed properly. NCERT recently organized a special conference to look into these suggestions.

"There is also a feeling that high technology areas which are also high investment areas, such as aeronautics, electronics, require major support and should be built up in a more extensive manner than before. In the area of energy, scientists have suggested that efforts to develop nuclear energy need to be intensified; that R&D and utilization of researches in the area of coal as a source of energy, as well as chemicals need urgent attention. Due emphasis is needed on promoting the renewable sources of energy It is felt that India should carry out intensive programmes of R&D in the field of biotechnologies and oceanography.

"Many of the scientists strongly feel that our information system, with regard to information on development in science and technology within the country and about other countries, is yet not as well developed as it ought to be. This requires urgent attention

"There is also the need to study the interface of science and society, to develop the culture of science and to ensure that science does not result either in dehumanising society or in the degradation of the environment. It is a vital area to which we should devote some attention and resources.

"I may also take this opportunity to convey to you the feeling of scientists about administrative and financial constraints imposed as a result of negative attitudes and lack of appreciation of the nature of research. Scientific research requires a different type of administration, an atmosphere of free enquiry, participation of the scientists in scientific decision-making, continuity of effort, closer linkages between institutions and mobility of scientists as between universities, research institutions and industry.

"This also raises the question of integrating science and technology with the other decision-making systems, such as industrial policies, decisions about import of technology, with fiscal policies, environmental practices, etc.

"A large number of scientific

institutions are unable to attract young scientists because of inadequacy of housing, educational facilities for their children and lack of some other basic amenities. Compared to industry or administration, scientists are not only paid less, but the chances of their promotion are few and far between

"Lastly, one notices considerable negative reporting in the press, much of it based on a lack of proper and correct information. There is an urgency for informing public regularly about the development of science and technology, India's achievements, India's policies and their implications for man, society and environment. We must take pride in our achievements which are not few and we must help to build up the prestige of Indian science and scientists, and thus help to build the confidence of our people in S&T and India's future."

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# S. S. Bhatnagar Awards—I

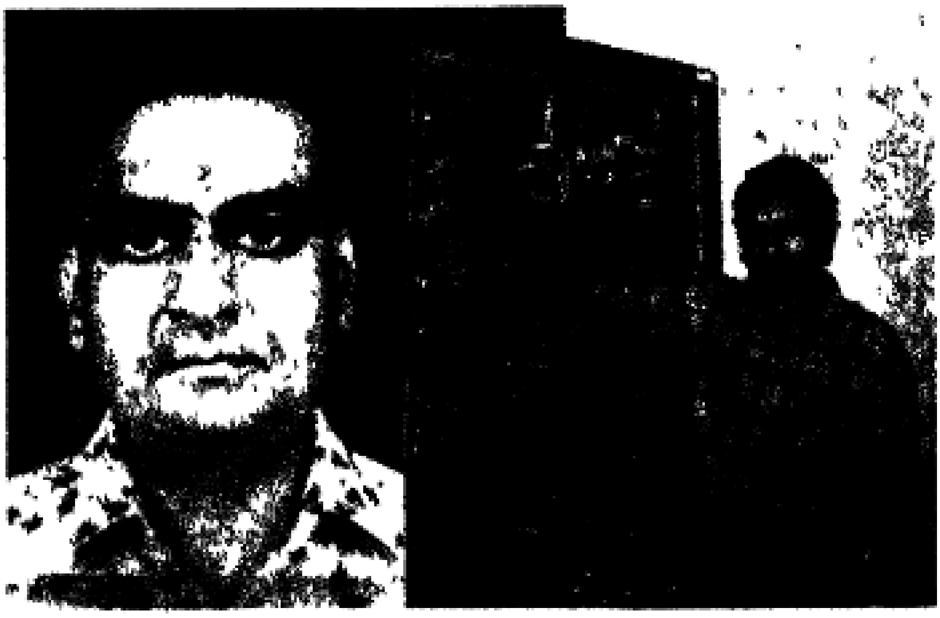
**The S.S. Bhatnagar Awards for the years 1978-79 were presented to 18 eminent scientists at National Physical Laboratory, New Delhi, on July 25, 1980. Dilip M. Salwi of our staff met some of the scientists and interviewed them for *Science Reporter* Interviews of two Awardees are presented below; others will follow.**

TALL, hefty and boyish are the physical attributes that make a man look not at all like a Professor. Neither do they make Prof. Goverdhan Mehta look like one, but there he is! He is only 36 years old and is already a Professor of Chemistry at the University of Hyderabad, Hyderabad, and now the winner of the S S Bhatnagar Award in chemical sciences for 1978. Only sheer hard work and dedication have made such things possible Today, he is the author of about 100 research papers published in reputed national and international scientific journals and a Fellow of the Indian Academy of Sciences He has also lectured at various national and international seminars and universities.

Prof. Mehta hails from Jodhpur, Rajasthan, the very heart of the Thar desert And in one sense the desert has certainly made him what he is today. Seeing very little vegetation in the neighbourhood of Jodhpur, he had at an early age begun to think why plants did not grow there His interest in botany thus grew but not enough to make a botanist out of him But botany served the purpose in that it made him realise the wonder world of chemistry, and since then he had never looked back. In his school and college examinations he used to secure highest marks in chemistry, which eventually decided for him his career.

Commenting on the students that Prof. Mehta comes across these days he says, "We don't catch as many dedicated young scientists as we would like to". He gives two reasons for this. First, culturally, we Indians have not yet caught on with the scientific temper and secondly, science is not a rewarding career in the country, despite the fact that "funding in science and technology not has been bad in the last five years".

The research work of Prof. Mehta and his group is in the field of organic chemistry, in particular the synthesis, structure and mechanism of various organic compounds. His aim has been to develop effective, new strategies for synthesis of a wide variety of organic molecules which possess either novel structural features or exquisitely simple, symmetric shapes. He has given special attention to the molecules with jaw-twisting names like sesquiterpenoid



S. S. Bhatnagar Awardees for Chemical Sciences. Prof. G. Govil (left) and Prof. G. Mehta (right) and diterpenoid natural products. The molecules like cubane, hexaprismane and dodecahedrane, which have exotic architecture, have also fascinated him. Recently, he has also discovered a novel reaction, called "olefin metathesis reaction", which can be used to store solar energy in some chemicals.

Prof. Mehta has been abroad a number of times and has some interesting comparisons to make of the conditions that prevail in India and the West. "In the western countries," he says," the spirit of adventure and inquiry is very high. Early in childhood a student's personality is built up. He does what excites him. Most of the students take their career by choice. In India we rarely do what excites us. We do what circumstances dictate us to do. There is thus a lot of drifting."

Associate Professor Girjesh Govil who has shared the Award with Prof Mehta, also has something similar to say in so far as our student community is concerned. The quality of young scientists in the country, he says, is deteriorating—in fact, "has considerably deteriorated in the last five years". According to him outstanding students go abroad. "We need to re-define our science policy", he adds emphatically, "At present we are thinking of socialism in science, which is not correct". He thinks that one cannot keep on giving 2,000 fellowships of Rs. 400 each for research. It is better to choose only 100 students carefully, give them a fellowship of, say, Rs. 1000 each and provide them all the facilities that their work demands. In this manner Prof Govil thinks we can attract the outstanding students we are losing every year to the West..

Born at Khurja, U.P., in 1940, Prof. Govil did M. Sc. from the University of Allahabad, standing first in the university. He has since childhood been interested in science and had never looked elsewhere for a job. In 1959 when he got the offer for Post-graduate Training from the Bhabha Atomic Research Center, Bombay, he jumped at it. He joined the Nuclear Magnetic Resonance (NMR) Group in the Center after listening to a lecture on the subject. NMR was then a newly developed technique. In 1963 he did his Ph.D. in the same subject from the Universtity of Bombay. After that he had been abroad a number of times for research. Today, he is a member of many reputed international and national committees, societies and editorial boards of reputed journals. His research work concerns the application of quantum chemical theories, statistical methods, magnetic resonance and molecular graphics to understand the structure and functions of biological molecules, dynamics and mechanism of biochemical reactions, drug activity and biochemical energy.

A soft-spoken and modest person, Prof. Govil is at present with the Chemical Physics Group of the Tata Institute of Fundamental Research, Bombay.

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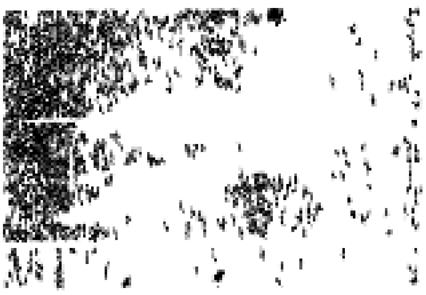

# Animal diseases and society

Man, *Homo sapiens*, is primarily a species of primate animal and lives in a world of over two million different species of animals and plants. He is the mightiest of all organisms on the earth, but lives at the mercy of the tiniest virus or bacterium! We all suffer from disease, at one time or the other, but scientific explanation for the same is still lacking.

Strange as it may appear, our skin forms an eco-system—a self-sustaining world of flora and fauna—where a number of parasites like sucking mosquitoes, bugs and ticks thrive at our expense. Yet their ancestors originally evolved as suckers of the juice of plants and took to life on man through millions of little evolutionary steps.

According to tradition, the first disease whose cause was definitely established, was the scabies caused by the itch mite, *Sarcoptes scabiei*. And would you belive, 50 per cent of the refugees from East Bengal (East Pakistan) who fled to India at the time of the Bangla Desh war had rabies? In a civilized society, in august company, how would you feel, scratching yourself shamelessly before others?

The human scabies mite *Sarcoptes scabiei* var. *hominis* Fig 1 is indistinguishstable in form from the varieties parasitising dogs and horses, measuring about 0.4 millimetres in length. Scabies is also fairly widespread in Europe and America.

The tropical rat flea, *Xenopsylla cheopis* (Fig. 2) also bites man, sucks many times its own weight in blood and plays a crucial role in the dissemination of plague. Record has it that plague took sixty million human lives in Europe between 1347 and 1350 A. D. Yet the connection between fleas and plague had not been definitely established until the discoveries of the Japanese bacteriologist Kitasato in 1894 in HongKong and the Japanese scientist Ogata in 1898. Plague was brought to India in 1895 by ships calling at Bombay, from Hong Kong, and killed 1,300,000 people in twenty years.

The body louse *Pediculus humanus humanus* and the head louse *Pediculus humanus capitis* are tiny insects which can be a source of constant irritation to the school childern. The louse is also the vector of the typhus causing organism, *Rickettsia prowazeki* and the relapsing fever spirochaete, *Borrelia recurrentis*.

Each one of us has had the experience of extreme irritation after a night's disturbed sleep due to the small bed bug, *Cimex rotundatus*. A single female bed bug can absorb at one meal a quantity of blood equal to twice the weight of its body. Bed bugs are able to endure long fasts; they have remained alive without any food whatever for a year!

The annual number of human deaths from rabies in India is estimated at 15,000 (Kaplan, 1977). Although the most highly susceptible warmblooded animals in this country are the foxes, jackals and wolves, they are without doubt responsible for the spread of infection (virus) to human beings. Hydrophobia caused by the bite of rabid dog is one of the most dreaded ailments because of the painfulness, mortality and circumances leading to the death of the bitten person if immediate and prolonged medical treatment is not provided.

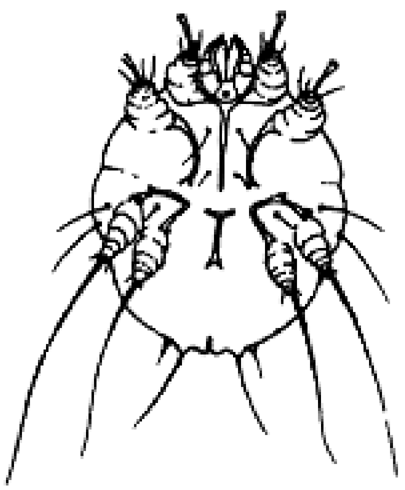

**Fig. 1. Human Itch mite, *Sarcoptes scabies***

There are a number of diseases caused by the protozoans, such as, malaria, Kala-azar, amoebic dysentery in India and African sleeping sickness in Africa. Kala-azar is transmitted by the sandfly (*Phlebotomus*), the causative organism being the flagellate *Leishmania donovani*. The protozoan causing amoebic dysentery, *Entamoeba histolytica* is spread through contamination of food or water, the most notorious culprit being the house fly (*Musca domestica nebulo*). The parasite lives in the mucosa and submucosa of the large intestine of man, and sometimes in the liver and other organs.

Three species of *Plasmodium* cause different types of malaria in man, viz., Benign tertian malaria caused by *Plasmodium vivax*, malariae malaria by *Plasmodium malariae* and malignant tertian malaria by *Plasmodium falciparum*. The chill-and-fever occurs respectively every 48 hours, 72 hours and irregularly in accordance with the completion of the asexual life cycle in the redblood corpuscle. All the three kinds of malarial fever are transmitted by the bite of the female mosquito of the genus *Anopheles*.

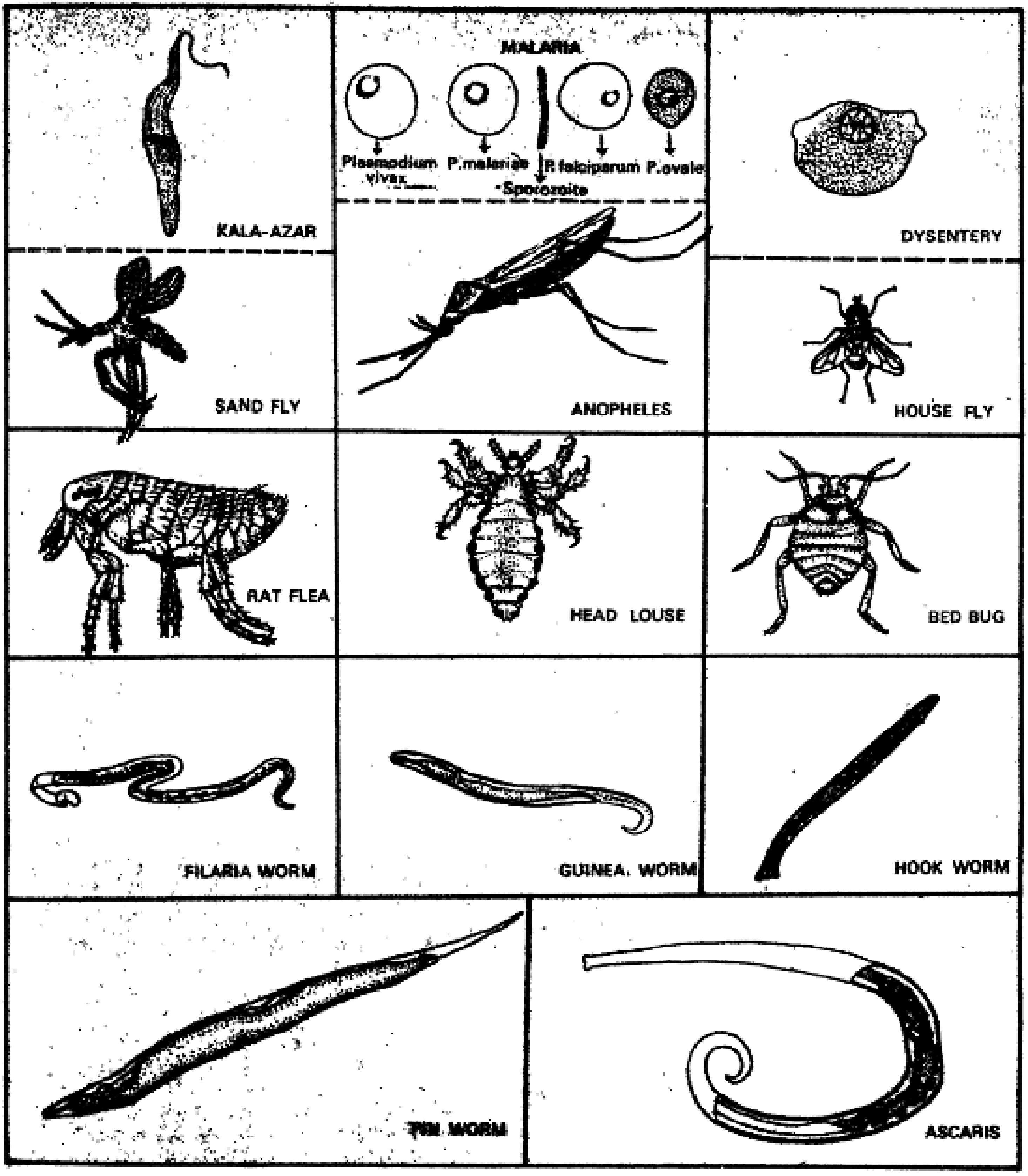

Fig. 2. Some animals that cause diseases in man

In 1950 WHO reported that malaria killed 3 million people. There was a period of respite due to extensive use of DDT. Due to the emergence of DDT resistant mosquitoes, malaria has again come back, to trouble mankind.

The flat worms and round worms are responsible for many dreadful human ailments requiring prolonged treatment. The beef tapeworm *Taenia saginata* infects man when

(*Continued on page 689*)

# SCIENCE FOR THE YOUNG

## William Harvey
## (1578 - 1657)

IT has been known since the dawn of civilisation that heart is the key to life and death However, man could not unravel the secrets of the heart and its function until William Harvey discovered the mechanism of the heart and the circulation of blood

William Harvey was born on April 1, 1578 at Folkestone in England His father Thomas Harvey was a merchant trading with Turkey and the Levant William was the second son of Thomas second wife Joan Halke who bore him seven sons and two daughters His mother died at the age of fifty Not much is known about her

With the exception of William and John the other sons of Thomas Harvey followed the profession of their father and became wealthy merchants After the Civil War, they speculated successfully in cheap land and became landowners John Harvey got a minor appointment at the court of James I, and William Harvey became a doctor William Harvey was financially supported by his well-to-do family Because of this sound economic support, he was able to achieve his scientific aims with concentration and diligence

After completing his primary education William Harvey was sent to King's School in 1588 at the age of ten Christopher Marlowe, the author of the famous 'Tamburlaine', was also a student of this school and was eight years senior to Harvey

William's ambition was to become a doctor At the age of sixteen, he went to Caius College, Cambridge to obtain a degree in arts, preparatory to the study of medicine In this college he secured the unique medical scholarship founded by Mathew Parker, the Archbishop of Canterbury This was the first scholarship to be founded in England for the education of a student preparing for medicine He graduated from Caius College in 1597

In Harvey's time England had no suitable medical school Good and serious students therefore went abroad for further study Padua, in Italy, had the most renowned medical school in Europe For William, going to Padua for further studies was no problem

Harvey entered the Padua medical school sometime in 1598/1600, the exact year is not known. He was in Padua a contempurary of the brilliant Italian anatomist, Fabrizzi. Harvey graduated from Padua as doctor of medicine in 1602 After that, he returned to England and again secured a doctor's degree from Cambridge.

In England, Harvey practised medicine. He married Elizabeth Browne, the daughter of Queen Elizabeth's doctor. She died childless around 1650

Harvey was admitted to the Royal College of Physicians in the year 1604 He was doctor to James I and Charles I for approximately thirty years In 1609, he became a doctor at St Bartholomew's Hospital In 1615, he was appointed Lumley lecturer at the College. He had to practice as well besides teaching in College He was a very diligent doctor and devoted time for research also

In research, Harvey followed the path of his Italian anatomist teacher, Fabrizzi Fabrizzi preferred dissecting living animals rather than dead ones, as only then the mechanism of a living organism could be understood Harvey applied these methods to heart The dissection of cold blooded animals proved more instructive as movement of heart could be clearly followed in them, whereas in warm-blooded animals it was too rapid to be observed

About 1614, at the age of thirty-six, Harvey made his great discovery that heart is a pump, continually circulating blood throughout the body He extended Fabrizzi's discovery that valves of veins open towards the heart and this led to his novel discovery of the circulation of blood He not only studied the direction in which the blood was flowing but also calculated how much and at what speed

The knowledge that heart is a pump which keeps the blood in continuous circulation made possible rational investigation of many diseases. New light was thrown on diseases of the heart, on respiration and on the supply of nutrients to tissues. The function of blood stream as a distributing agent and a remover of waste products became clearer. A more correct understanding of the mechanism of these processes led to better medical treatments for several ailments.

Harvey also made significant contribution in the field of embryology after Aristotle, the Greek Philosopher. He stipulated that development of egg consists of a series of changes of ever-increasing complication, in a material which was originally the same throughout. He also stated that all living things originate from an agg. His work is written in Latin in his book *Omne Vivum Ex Ovo*.

Harvey was a man of short stature. He was a very nice and amiable person full of high spirits and devoid of all pride. He was fond of leading an isolated life to meditate in peace.

In 1657, came the sad end of this great doctor and researcher. He was laid to rest at Hampstead in Essex amidst other members of his family.

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# Brain teasers

### 1. Who's the culprit ?

Eight suspects named Abdul, Bhola, Chaman, David, Edward, Feroz, Gopal and Hemant were held up in a theft case. Of these, however, only one person is the culprit When the eight men were interrogated, they tried to confuse the police. But the brilliant police inspector using sound logic and careful reasoning, was ultimately able to figure out the guilty man knowing that exactly half the suspects were telling lies but not knowing just who they were. Let us see if you can also detect the culprit. Here are the statements of the eight men:

1. Edward : "Either Abdul or David is guilty."
2. Chaman : "Nobody did it."
3. Bhola : "Chaman and Edward are entirely innocent."
4. Feroz : "Gopal is telling the truth."
5. David : "Chaman is the guilty man."
6. Hemant : "David is innocent."
7. Abdul : "It was Edward who did it."
8. Gopal . "Hemant is a liar."

### 2. A problem of age

Prem Singh is 30 years older than his son. If his son's age be placed before his, the four digit number thus obtained is a perfect square. In twentyfive years their ages taken in the same sequence will similarly form a four-digit square What are the ages of Prem Singh and his son?

### 3. The cinema ticket

Mr Raj's eyes fell on the ticket he purchased from the counter of a local cinema theatre. "Interesting", he muttered to himself as he examin-

## Sponge

MY friend Protozoan,
spoke of his fame :
I a sub Metazoan
have come to submit mine
A step ahead in advancement
Multicellular 'am in construction
A body perforated by pores
hence 'am grouped as porifera
Bare with no organ system
my body is spongy soft
To protect a body so spongy
I have a wall made of spongin
I feed through canal system
A peculiar specialised system
The presence of choanocytes
is quite a feast for scientists' sight
Attached to the substratum
My home is but the vast sea
Why not come and view me ?
a small but fine organism.

S. USHA MANI
*Jogamaya Devi College*
*(Ashutosh College)*
*Calcutta*

ed the number printed on the ticket, "It has five different digits; the first pair and the last pair are squares. So is the middle digit. Also, the whole number is a square and the root of the number is a prime as well as a palindrome. I am sure this is unique." Certainly that number was unique. Can you figure it out ?

P. K. MUKHERJEE
*Lecturer, Department of*
*Physics, Deshbandu College*
*Kalkaji, New Delhi-110019*

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## Zoology Quiz

(1) Encephalitis disease is transmitted by
(a) House fly (c) Mosquito
(b) Cockroach (d) Horse fly

(2) Largest egg in the animal kingdom is laid by
(a) Crocodile (c) Ostrich
(b) Eagle (d) Vulture

(3) Which of the following reptile is a lizard
(a) Turtle (c) Crocodile
(b) Calotes (d) Snake

(4) The only mammal having nucleated RBCs in the blood is
(a) Camel (c) Deer
(b) Elephant (d) Lion

(5) Which of the following causes the disease sleeping sickness
(a) Amoeba (c) Gregarine
(b) Plasmodium (d) Trypanosoma

(6) Which of the following Reptiles has completely four chambered heart
(a) Draco (c) Calotes
(b) Crocodile (d) Varanus

(7) The echinoderms are exclusively found
(a) On land (c) In sea water
(b) In fresh water (d) Both in fresh and sea water

(8) The father of the "Binomial nomenclature" was
(a) T. H. Morgan (c) Carl Linnaeus
(b) Charles Darwin (d) Lamark

MALLIKARJUN C. AKKI
*Department of Biology*
*V. M. S. R. Vastard College*
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## MEDICAL NOTES *(Continued from page 679)*

underboiled beef is eaten. An estimate in 1951 placed the infection at 39 million people. Similarly, two and a half million people get infected by the pig tapeworm *Taenia solium* when undercooked pork is eaten. *Ascaris lumbricoides* is the common intestinal roundworm of man infecting 644 million people. The pin worm or seat worm *Enterobius vermicularis* is found especially in children and as many as 209 million children suffer from it. The pork trichina worm *Trichinella spiralis* causes trichinosis in 27 million people by encystment in the striated muscles when underboiled flesh of pigs are consumed. The human hookworms *Ancylostoma duodenale* and *Necator americanus* are common in man. They attach themselves to the inner wall of the small intestine and suck blood. This accounts for the 'laziness' of 456 million people. Infection occurs due to people easing themselves in open fields and going about barefoot. The guineaworm *Dracunculus medinensis* occurs in the water scarce areas of India, Arabia and Africa. Its larvae live in the water fleas (*Cyclops*) and infection occurs when they are swallowed through drinking water. Bancroft's filarial worm *Wuchereria bancrofti* infect 189 million people and is transmitted by the female *Culex* mosquitoes.

Animals which cause disease in man directly or as vectors are not concerned with human values. They do not distinguish between the rich and the poor, genius or the dull. They are compelled by natural urges to get their food, mate with their own kind and attempt to ensure the survival of their species.

Two features of our modern civilization, the internal combustion engine and aeroplanes greatly contribute towards the rapid transport of diseases from one corner of the globe to the other. For example, in 1930, the malaria carrying mosquito, *Anopheles gambiae* was transported by aeroplanes and fast naval destroyers from Africa to South America with the result that the city of Natal in Brazil experienced in 1930 and 1931 two severe outbreaks of malaria.

The impact of animal diseases on society is enormous. Malaria, filaria and ancylostomiasis kill tropical industry leaving a deep impact on the society. Colossal sums of money are spent on the cure of these diseases, leave alone the suffering of man. Man's loss due to confinement and the money spent on research work to learn more about the biology of the animals responsible for producing such diseases and to devise curative and preventive measures are enormous.

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## *Solutions and answers*

### Brain teasers

1. Use the diagram shown in Fig. 1. and assume that each man is telling the truth. The letters A to H represent the initials of the eight men. Fill in each column using a check (✓) for guilty and a ( ) for innocent. When you have completed filling you can see that the only row containing 4 dots and 4 checks is the D row This indicates that four of the suspects (B,E,F and G) gave true statements while the remaining four (A, C, D and H) lied This satisfies the condition envisaged in the problem. Hence David is the guilty man

2. It will be noticed that the four-digit number formed by placing Prem Singh's son's age before his own age will be increased by 2525 after 25 years If $A^2$ represents the four-digit square number formed by their present ages and $B^2$ that formed by their ages after 25 years,

| | A | B | C | D | E | F | G | H | |
|---|---|---|---|---|---|---|---|---|---|
| A | • | ✓ | • | • | ✓ | • | • | ✓ | |
| B | • | ✓ | • | • | • | • | • | ✓ | |
| C | • | • | • | ✓ | • | • | • | ✓ | |
| D | • | ✓ | • | • | ✓ | ✓ | ✓ | • | ◆ |
| E | ✓ | • | • | • | • | • | • | ✓ | |
| F | • | ✓ | • | • | • | • | • | ✓ | |
| G | • | ✓ | • | • | • | • | • | ✓ | |
| H | • | ✓ | • | • | • | • | • | ✓ | |

Fig 1

$$B^2=A^2+2525 \qquad ..(1)$$

which gives

$$(B+A)(B-A)=2525 \qquad ..(2)$$

Now factorise 2525 into factors 5, 5, and 101. The pairs of factors of 2525 are 2525 and 1, 505 and 5, and 101 and 25 A set of values for A and B is readily obtained

A 1262, 250, 38

B 1263, 255, 63

As both $A^2$ and $B^2$ represent four-digit squares, it is evident that the only right choice is A=38 and B=63 giving $A^2=1444$ and $B^2=3969$. Prem Singh's age is therefore 44 years, his son's is 14 years.

3. As the number on the cinema ticket has five digits, its square root must be a three-digit number. Being a palindrome this three-digit number must be of the form aba. Now, the number aba must lie between 100 and 316 for otherwise its square would not comprise five digits, since $99^2 = 9801$ and $317^2 = 100489$ The aba number is a prime number Therefore, only those numbers are to be selected from the range 100 to 316 which are palindromic primes These numbers are 101, 131, 151, 181, 191 and 313 Their squares must yield five-digit numbers in which the first and the last pairs, as also the middle digit, are squares Trial shows that 191 is the only number that possesses these characteristics So, the number on the cinema ticket was $(191)^2$ or 36481

**Answers to zoology quiz**

(1) (c), (2) (c), (3) (b), (4) (a), (5) (d), (6) (b), (7) (c), (8) (c).

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**OXFORD & IBH PUBLISHING CO.**
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# Getting the most out of potatoes and tapioca

POTATOES, alone or in combination with meat, fish and other vegetables, provide delicious eating to many a consumer, irrespective of age. For some, potatoes are simply irresistible inspite of the repeated warnings by friends that the habit causes obesity. In our modern teenage culture crunchy potato chips fried in deep fat go a long way with popular soft drinks.

Tapioca, the tuberous root of a palm-like shrub known botanically as *Manihot esculata* is a delicacy for most Malayalis (Keralites), when eaten with fish curry. The tuber is already a commercial crop and is cultivated extensively in Kerala and on smaller scales in Tamil Nadu, Assam and Andhra Pradesh. For the poor in these states, tapioca is the main staple food.

It is worthwhile investigating how nutritious are these tubers and how best they can be utilised as food, without causing harm. A 100 gm portion—one small potato—can contribute a number of essential nutrients and vitamins as shown in Table 1.

**Table 1**

| *Mineral/ Vitamin* | *Weight in milligram* |
|---|---|
| Calcium | 10 |
| Phosphorus | 40 |
| Iron | 0.70 |
| Thiamine (vitamin $B_1$) | 0.10 |
| Riboflavin | 0.01 |
| Niacin | 1.20 |
| Ascorbic acid (Vitamin C) | 17 |

Potato also contains folic acid, pantothenic acid, pyridoxine and vitamin C. It is a good source of potassium, besides containing traces of sulphur, iodine, sodium and magnesium. An average medium-sized potato boiled with its skin supplies about 25% of the ascorbic acid (vit. C) recommended for a 25 year old man; 8% to 10% of iron, thiamine and niacin; 4% of the protein, riboflavin and food energy. Considering the low cost, this is a good nutritional investment.

Contrary to common belief, potato is not a starchy fattener. A medium-sized potato, cooked plain, furnishes the same number of calories as a fairly large banana, apple or a large orange. It is the fat added to them that makes them fattening. A 100 gm portion of boiled potato supplies about 90 calories. If potato is fried (starting with raw potatoes) the energy value rises to 280 calories.

Cooking is an important factor which affects the amount of nutrients available from potatoes. In general, retaining the skin is effective in reducing loss of minerals and vitamins during cooking. Therefore it is desirable to bake, boil or steam potatoes whole. Peeled potatoes do not lose much nutrient if they are boiled in a little water. But mashing and recooking potatoes after keeping overnight in a refrigerator considerably lower vitamin C and thiamine levels. Therefore the thriftiest way of cooking potatoes is to boil them in their skin and use them right away.

Potatoes are also known to contain about 50 distinct chemical substances that are of no food value to man. Nitrites, tannins, oxalic acid and the solanine alkaloids form a part of this group. Substances that reduce enzyme activity, cyanide-forming compounds and substances formed as a result of insect or fungal infestation may also be present. There seems to be a high correlation between consumption of potatoes infested with a fungus disease called Late Blight (*Phytophthera infestans*) and the incidence of certain serious birth defects. Obviously mothers, especially in the first few months of child bearing should avoid blighted potatoes. Sometimes certain portions of the vegetable turn green—a process called 'greening'. This is due to the production of chlorophyll. Such green potatoes usually contain high amounts of solanine glycoalkaloids. Bruising can also induce their formation. If these alkaloids are present in amounts around 20 mg or more for every 100 g of fresh weight, a bitter taste becomes noticeable. Giddiness, acute stomach upset, vomiting, diarrhoea and a burning sensation in the throat are some of the symptoms of alkaloid poisoning. Cooking removes some of the enzyme inhibitors present. All mouldy, green or dark portions of the potato should be discarded because the toxin present due to fungi and other organisms are not always destroyed by cooking.

Another tuber which has acquired considerable significance in the southern part of India, particularly in Kerala, tapioca is also known as cassava. The crop is far more versatile than potato, even the young leaves of some varieties are edible. Tapioca starch finds its way into alcohol production, laundering, sizing paper, adhesives and cosmetics. The tuber is however very poor in protein content. This is why children in some African countries where it is the staple food suffer from kwashiorkor and protein malnutrition. In southern states, however, its combination with fish makes it less likely to cause protein deficiency. The little protein that is present in the tuber is of good quality and compares favourably with rice protein. Methods are now being evolved to supplement this amount with extra protein from other cereals and groundnuts.

Tapioca supplies some calcium and phosphorus, besides traces of iron, but unlike potato it contains little vitamin. Vitamin C that is present is entirely lost during processing. Tapioca contains certain toxic substances concentrated mainly in its skin and inner rind and therefore processing is absolutely necessary for its safe use. Peeling off the whole skin, thorough rinsing followed by boiling or parboiling are commonly carried out to eliminate the toxic principles.

Tapioca is often ground with water and left for a while to sediment the starch. This starch after drying in the sun is granulated and lightly roasted in shallow vessels coated with oil. The resulting 'sago' can be utilized to make gruel pudding and weaning foods.

Proper storage is important for all tubers. When they are stored, it should be ensured that they are fairly clean, mature and free from injury. Air should be able to freely circulate but no direct sunlight should reach them since this produces greening in potatoes. Moisture should be carefully excluded. Such precautions ensure that you get all the nutrients that you paid for.

In conclusion, it must be said that potatoes and tapioca are filling and more or less nutritive, but must not be consumed as a staple. If they are stored and cooked well they offer a wide variety of wholesome foods.

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# How to remove birth marks

A birth mark is a pigmented area or a congenital skin blemish on the body. These marks are usually small and insignificant at birth but grow larger and become prominent when the child is a few weeks old. They may stop growing and may even disappear in some cases. Among some individuals, these birth marks develop after a few years from birth but a careful examination reveals that the skin there is defective from the beginning and in some cases it starts with the formation of the skin of the fetus.

Birth marks are of various types.

(*a*) *Strawberry*. These marks include pigmented moles and skin decolourations brought about by blood vessels. They are formed by clustering of a mass of blood vessels near the surface of the skin. Superficial strawberry marks are bluish but show scarlet colour when they are deep below the skin. The characteristic feature of these marks is that they appear colourless when pressure is exerted on them. Its colourlessness is due to the blood forced out of blood vessels. That these marks often disappear or become inconspicuous with age without surgery or other treatment.

(*b*) *Port-wine*. The port-wine marks are a type of skin blemish due to collection of small blood vessels which are associated with various amounts of pigments deposited from blood into the skin. These birth marks are rarely found enlarging in the body. (*c*) The third type of birth mark is usually either pale blue or grey in colour. These marks differ from the strawberry type in that their colour cannot be pressed out as they contain a smaller number of blood vessels. Further, they are characterized by the presence of more cellular tissue and less fluid. They are also less spongy than other marks.

Various methods are in vogue for removal of birth marks. Treatment with ultraviolet rays causes complete disappearance of the mark. Skin lesions of the birth mark are usually treated with electric needle, radium or by applying different chemicals, viz., carbon dioxide snow, carbolic acid, nitric acid, etc. Occasionally surgical interventions are needed to remove a birth mark. Recently, a method called 'plastic planing' has been developed for the same purpose. In this method the marks are scraped or planed away with an emory wheel and new skin is allowed to grow. The most modern method, however, is to inject various chemical substances in blood vessels in skin growth. These chemical substances cause an inflammatory reaction in the area leading to the disappearance of the birth mark.

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# Science in Industry

## NCL process on dimethylaniline

BASED on the continuous catalytic vapour phase methylation of aniline, a process has been developed at the National Chemical Laboratory (NCL), Pune, to produce on a commercial scale dimethylaniline (DMA). DMA is an important intermediate used in the dyestuff industry and also in the manufacture of Tetryl (N-methyl-N,2,4,6-tetranitroaniline), a booster explosive.

NCL took up the development of a novel process for the manufacture of DMA from aniline and methyl alcohol by a continuous vapour phase catalytic process. The laboratory not only developed the process successfully but designed a semi-commercial plant of 300-400 tonnes/annum and operated it successfully to produce 1000 tonnes of the product of the required specification. Subsequently a firm has designed and installed a commercial plant of 3600 tonnes/annum capacity at Dewas. Development of the DMA technology at NCL is one of the several instances of the fruitful collaboration between NCL and industry in developing much-needed technologies for the chemical industry in the country.

The vapour phase catalytic process is unique and the first of its kind in the world. The activity of the catalyst is maintained at a steady value by continuous introduction along with the feed stream of an activating agent.

During 1978-79 (5 months) the firm produced, by the continuous process, about 756 tonnes of DMA valued at Rs. 180 lakh.

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## Carbon refractories

CARBON refractories find application in different areas of iron and steel industry because of such properties as non-wettability and volume stability. It is estimated that the consumption of these refractories in the range of 2000-3000 tonnes/annum, which is likely to increase further. These refractories are being imported at present.

The Central Glass & Ceramic Research Institute (CGCRI), Calcutta, has developed carbon refractories which have the following characteristics porosity, 18-21% (approx.); bulk density, 1.5-1.62 g/cc; cold crushing strength, 350-472 kg/cm$^2$; modulus of rupture, 85-113 kg/cm$^2$; carbon content, 94-98% and ash content 2-6%.

In the CGCRI process, a selected variety of petroleum, coke which is indigenously available, is crushed and graded into differents size fractions to obtain an aggregate of coke particles of maximum density. Preheated coke particles are intimately mixed with the molten tarry bond and the mixed mass is moulded to the desired shape and size by the application of pressure or by ramming. The body duly compacted in a shape is fired at temperatures above 1000°C under strictly controlled conditions. The laboratory has tried the process in three stages, producing samples of the following sizes weighing up to 25 kg: laboratory bench type slap, 225×112×(25-40) mm; full bricks 225×112×(75-77) mm; LD converter blocks, 350×(200-165)×190 mm. The products were evaluated both at the institute and at the Rourkela Steel Plant for performance.

The raw materials required are: calcined petroleum coke, pitch and tar, etc. All these are indigenously available.

The machinery and equipment required are: electric drier, melting oven, hot mixer, air compressors and rammers, moulds, device for heating mould, device for cooling the moulded product, device for material transfer, safety measures and muffling arrangement inside the kiln. Other equipment needed include machines for crushing, grinding, sieving and weighing. Also, firing facilities will have to be made available in the plant.

The capacity of the suggested economic unit is 200 tonnes/annum. The capital investment needed for such a unit is as follows: fixed capital on building, Rs. 51,000; fixed capital on plant, Rs. 2.70 lakh; and working capital, Rs. 4 lakh.

The process can be taken up by those manufacturers who have facilities for making refractories.

## TECHNOLOGY FOR VILLAGES

# Uses of tissue culture technologies

NATIONAL Chemical Laboratory has developed a method of vegetative propagation of high yielding cabbage based on tissue culture technique. Large-scale cultivation trials are in progress at the Nimbkar Agricultural Research Institute, Phaltan, near Pune, for economic assessment of the technique. NCL has also employed tissue culture technique for developing a mosaic free sugarcane strain. Field trials are in progress at the Nimbkar Agricultural Research Institute, Phaltan for obtaining a sufficiently large number of seedlings to plant a few acres under this sugarcane for comparison of yields with other strains. Tissue culture technique is also being applied to the multiplication of trees and plants which offer difficulty in multiplication by the conventional methods, e g., teak, eucalyptus, cardamom, etc. Attempts are being made to propagate the best variety of teak trees in "Glory of Allapalli" forest in an assured manner through tissue culture technique. National Botanical Res. Institute (NBRI) has perfected a method for the mass propagation of *Dioscorea floribunda* by tissue culture technique.

NBRI is working on production of more than 40 new cultivars of popular ornamentals with a view to produce seeds of hybrids and polyploids, work out plant protection measures, etc. Considerable amount of work has been done by NBG for the introduction of grapes in Uttar Pradesh and standardisation of its agro-techniques.

NBG has developed a biological method for the reclamation of "Usar" land which is normally uncultivable. This "Usar" land is being utilised for cultivation of unconventional economic crops such as Guar, Isabgol and Dhaincha. The Institute has a number of projects dealing with introduction, conservation propagation, genetic upgrading, disease control and utilisation of medicinal and aromatic plants, ornamentals and subsidiary food plants.

Regional Research Laboratory, Jammu has promoted mushroom growing industry in the Kashmir valley by developing spawns of mushrooms and supplying them to villagers for mass production. It provides training and advisory service to the mushroom growers in the application of new techniques. Central Food Technological Res Institute (CFTRI) is working on a project on mushroom cultivation and its processing. NBRI has developed cottage scale technology for cultivation of two varieties of edible mushrooms—paddy straw (*Valvariella volvacea*) and white (*Agaricus bisporrus*). The technology is suitable for adoption on village scale due to its simplicity without requirement of any air cooling or airconditioning arrangement.

Hops (*Humulus lupulus* Linn) was a crop, practically unknown to the country. RRL, Jammu, has developed complete technology for its successful cultivation particularly in the Kashmir valley. Based on the planting material provided by the laboratory and under their consultancy some of the breweries have set-up their own farms for Hops cultivation. So far, the requirement of Hops for brewery industry to the tune of Rs 40 lakhs was entirely met by imports. Its cultivtion can now be taken up in J & K and Himachal Pradesh.

CFTRI has worked out a method for increasing the yield and quality of pine apple besides improving their shape which brings down their processing losses. Indian Jute Industries' Res Association (IJIRA) has developed three processes for upgrading of jute at the cultivators level by introducing some modifications in the usual retting process. These processes give treated fibre of higher grade in a shorter time.

A project of CSMCRI for growing economic crops using sea water in sand dunes in the coastal rural areas is in progress at Hatab, near Bhavnagar. A similar project has also been taken up by the Institute, in the Ganjam District near the eastern sea coast. It has been found that onion and sweet potato can be grown in saline water.

NCL has implemented a scheme for conservation of water by employing water evaporation retardants developed by it. This evaporation retardant when used on medium and large reservoirs in the country is likely to result in considerable savings of water from evaporation loss resulting in availability of more water for cultivation.

# Medicinal and aromatic plants

RRL, Jammu has undertaken investigations on the improvement, introduction and cultivation of a variety of medicinal, aromatic and other economic plants which fetch better economic returns per unit hectare, provide better rotation of crops and ensure effective utilisation of marginal and sub-marginal lands. The projects completed include medicinal plants like Belladonna, Hyoscyamus, Datura, Digitalis, *Ammi majus*, *Ammi visaga* Ergot of Rye, *Gloriosa superba*, Dioscorea, *Costus speciosusus*, *Solanum khasianum*, Fagopyrum, *Glycyrrhiza glabra*, Rauolfia and Colchicum; aromatic plants like Mentha, Eucalyptus, Cymbopogon, Ocimum, Lavender, Matricaria, Anethum, *Salvia officinalis*, and *Thymus vulgaris* and others like Pyrethrum and Hibiscus. The research programmes on the above plants are modified from time to time in an effort to evolve improved cultivars with better crop yield and active principle content per unit area and to develop better cultivation practices including pest and disease control.

Central Institute of Medicinal and Aromatic Plants (CIMAP) has completed projects on development of techniques for economic cultivation of Japanese mint, *Citronella java*, and Pal marosa. Ergot of Rye (*Claviceps purpurea*) is being cultivated in Jammu and Kashmir (production about 14.5 tonnes annually) and is now being introduced in Haldwani (UP) and Kumaon Hills. *Dioscorea deltoidea* Wall which is a source of diosgenin for manufacture of sex hormones and oral contraceptives is now being brought under regular farm cultivation. Agro-technology for cultivation of Dioscorea and process for manufacture of diosgenin therefrom has been provided to a number of interested parties. *Catharanthus roseus* (Syn. *Vinca rosea*) is a source of an anti-cancer drug. The plant has been introduced at Bangalore and its cultivation know/how developed. An improved strain of Coriander (*Coriandrum sativum*) CIMPO-S-33 has been evolved at Bangalore Centre through intensive selection from Bulgarian seed stock. The new seed yields 2117 kg of seed per hectare with 1 3 per cent of essential oil.

RRL, Jammu-Tawi has done extensive work for the development of know-how suited to local conditions, for the cultivation of essential oil bearing plants like Citronella, Lemon grass, Japanese mint, Pepermint, Palmarosa, Eucalyptus, Basil, etc. medicinal plants like *Solanum khasianum*, Dioscorea, and pesticidal plant like Pyrethrum. Three experimental cum-demonstration farms have been set up in Yaongyimson village (Nagaland), Imphal (Manipur) and upper Shillong (Meghalaya) with a view to identify and assess the indigenous economic plants of the region that may provide a basis for establishing industries based on them. The Laboratory had undertaken a botanical exploration in Twang area of Arunachal Pradesh in association with NBG, Lucknow, RRL, Jammu and BSI, Shillong. It has been providing known-how, planting material and advice for expanding the cultivation of such of these plants particularly citronella in the hilly areas of N.E. region.

RRL, Bhubaneswar is engaged in the cultivation studies and genetic improvement of Palmarosa, *Eucalyptus citrodora*, *Cinnamonum zeylanicum* and *Solanum khasianum*. The Laboratory did trials for the cultivation of *Solanum khasianum*.

NCL in collaboration with the forest authorities have collected extensive information on the medicinal and aromatic plants available in Chandrapur district which could be cultivated in a planned manner on large-scale to support suitable phytochemical/essential oil industry in the area. It is proposed to undertake studies on Dikamali (*Gardenia gummifera*), Garari (*Cleistanthus collinus* Benth), *Solanum* spp. *Dioscorea* spp. etc. Several plants which show insecticidal or insectrepellant properties have been identified.

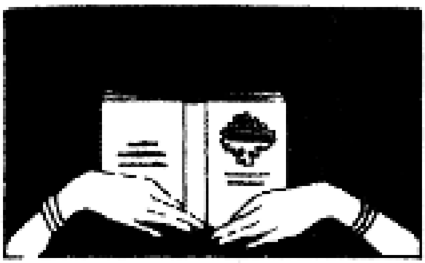
## INSTRUMENTATION

*(Continued from page 655)*

many areas so that one can develop a broader base of measurement technology and provide sound foundation for future scientific achievements. Individual autonomous instrument systems to make measurements desired by experimenters and mission directors, the situation would be chaotic. One possible solution is to use adaptive, computer controlled, integrated instrumetation systems, in which each successive measurement is contingent on the value of the previous one. The Automated Biological Laboratory of the Voyager Project is a step in this direction.

Instruments and advanced computer technology with controlled feedback can be particularly useful for an emergency situation. If an astronaut is incapacitated in a hazardous situation it would be necessary to evaluate the environment or the situation with local on-the-spot intelligence.

The need for real-time measurements or on-line measurements is another problem that we must tackle rigorously. This is needed for space applications, for ground facility and for aircraft deevlopment.



# BOOK REVIEWS

**THE COSMIC CONNECTION** *by* Carl Sagan, *Coronet Books* (Available from: *Macmillan Co. of India*, 2/10, Ansari Road, Daryaganj, New Delhi-110002), Pp. 274, Rs. 16.15.

IN recent years a lot of new science writers have made their name in the field of science popularisation but there is none to beat Carl Sagan, the author of the book under review. He is not only the first science writer to win the prestigious U.S. Pulitzer Prize for his *The Dragons of Eden*, his writings have also given a new direction to the exposition of science to the layman. At present, a Professor of Astronomy and Space Sciences at Cornell University, U.S.A , he is a scientist who has worked in the field of planetary science and exobiology. He was also a part of the team that studied the data sent by the various spacecraft to Venus, Mars, Jupiter, etc. But unlike a scientist he has a lively way of presenting the subject and linking what are apparently unrelated facts, which make his writings immensely readable and, on occasions, thought-provoking. *The Cosmic Connection* is one of his earlier books but with all the rich variety of material that the author is capable of providing to the layman.

It is essentially a collection of essays whose central theme, as the title indicates, is the common thread that runs through man, earth and cosmos. Whether it is the formation of earth or other planets in the solar system (or, for that matter, any star system) or the evolution of intelligent life on earth or elsewhere, or the spread of technological civilizations any where, the author argues, all are governed by the same basic laws and forces. It is only on the surface do they all look different, thanks to our terrestrial "chauvinism" which forces us to measure everything by earthly standards.

In this cosmos there could be many variety of worlds, some too hot like Venus or too gaseous like Jupiter; some having creatures that eat rocks and others with Time-machine-like fantastic gadgets; then there could be sophisticated worlds which use black holes for travelling from one universe to another and others having shell-like colonies around their stars, so on, so forth. So to communicate with all these various kinds of intelligent civilizations in the cosmos, the author argues, a common language based on well known scientific and mathematical principles is an essential requirement. Some efforts have already been made to send messages to, or receive messages from, other civilizations without any success. In the Preface only the author has stressed the importance of these efforts and how they are likely to benefit us in the long term.

The essays touch upon a wide variety of topics from astrology, Bible and Greek myths to evolution of life, astrophysics, exobiology and interstellar communication. These are interspersed with a number of interesting experiences the author had with military intelligence, dolphins, tiny-tots, Pioneer-10 plaque, and Arthur C. Clarke's Science Fiction film *2001: Space Odessey*. He has also mentioned his detective-like work on the moons of Mars, Mars and Venus. Besides the book is also replete with his own ideas and speculations on various cosmological questions. The selection of black-and-white paintings to illustrate the theme of some of the essays is also done well.

After reading the book the reader is sure to become increasingly aware of the molecular reactions that link him with the cosmos and his own humble anthromorphic existence on this chip of a planet called "earth". The book would otherwise be educative in a very special sense to all those homo sepians who play dirty politics and always clamour for blood and war Extra-terrestrials beings, if they could read English, would also greatly benefit from the book In these days of inflation, this low-priced good book is a welcome purchase for all.

DILIP M SALWI

**THE INNER LIMITS OF MANKIND—Heretical Reflections on Today's Values,Culture and Politics** *by* Laszlo (Ervin), *Pergamon Press*, Headington Hill Hall, Oxford, 1978, Pp.79.

THIS is a valuable book appearing at a right moment when the world is faced with the grave problem of environmental degradation. Here is one more book which adds to the discussion started by the Club of Rome on *Limits to Growth*. While most of the authors have earlier talked about outer limits to growth, the author here discusses inner limits of mankind and attempts to analyse how our natural environment could be maintained for the best of the mankind through human values, better cultures and political willingness.

The book starts with a commentary by Aurelio Peccei of Club of Rome where he points out that if mankind is in trouble because of environmental degradation, it is not because of the external causes but due to narrow-mindedness and poor self-governance. The problem of the quality of life and survival and human destiny generally, thus clearly, lies within man, and not outside him. In the introductory part the author reflects the dominant consensus in western societies that the degradation problems are mainly physical and ecological in nature and they can be solved by more and higher technology. But it is forgotton that with this we are applying only peacemeal solutions to global problems rather than giving a thought for a permanent solution.

The critical issue confronting mankind is that its truly decisive limits are inner, not outer. They are not physical limits due to the finiteness or vulnerability of this world, but psychological, cultural and above all political limits inner to people and societies manifested by individual and collective management irresponsibility and myopia. The root causes even of physical and ecological problems are the inner constraints on our vision and values. The author in the next three chapters discusses the personal, cultural and political limits in an attempt to solve the global problems of environmental degradation and unequal distribution of economic gains between developed and developing countries.

Discussing the personal limits he points out that the quest to become modern which involves the haphazard exploitation of non-renewable resources is a serious threat to the future of mankind. He emphasises that achievements of the modern age are to be preserved and furthered, but they must be framed on a new social, economic, political and cultural context, since the traditional values and aims of modernism are beginning to backfire. Returns on investments in modernism are diminishing and many of its once touted benefits are turning into burdens. Realizing this the author stresses that mankind must shift its values and goals now when it has propelled itself into a globally interdependent, crowded and technology dependent world. Discussing the cultural limits he points out that the challenge to contemporary cultures is no less important than the challenge to individuals and political systems. The challenge to cultures is to overcome the inner limits inherent in negative thinking and on clinging to absolute methods of seeking to pass whatever positive vision still holds sway in society.

Discussing the political limits the author stresses that unless the global partnership and global goals are determined and pursued through international cooperation, insecurity, hunger, energy and resource shortages, economic stagnation and rich-poor gaps will worsen and reach catastrophic dimensions. There is no inherent reason why a far-sighted global partnership could not be formed to act upon. The inner limits associated with the current crisis of political will is eliminatable.

Having discussed the personal, cultural and political limits the author gives some concrete suggestions and sets some ground rules for orientations of human aspirations and for the interrelationships of nations and peoples to evolve a society on which different cultures, ideologies, values and ideals flourish side by side and to mutual benefit. Finally, in the Appendix he gives an idea of the information of the global problems taking case studies of the USA and India. On the whole the book contains thought-provoking information and is a good stimulant for perceiving the frontiers of the inner limits of mankind. It makes aware of the hazards of modern society which is flourishing at the cost of non-renewable resources and environmental degradations.

V. P. KHARBANDA

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**BIOLOGICAL APPLICATIONS OF SOLAR ENERGY—*Proceedings of the International Symposium*, Edited by A. Gnanam, S. Krishnaswamy and Joseph S. Kahn, *The Macmillan Co. of India Ltd*, 2/10, Ansari Road, Daryganj, New Delhi-110002, Pp. 215, Rs. 75.00.**

THE realisation that we are living in a world of severely limited energy resources has prompted in the past few years a sudden spurt in research activities on development of alternative sources of energy to replace non-renewable sources such as coal, oil and gas. One of the most attractive alternatives today happens to be solar energy, which is abundantly available, at least in the developing countries as most of them lie in the tropical belt.

But research in this field has so far been limited to development of solar thermal and solar photovoltaic systems—both of which are capital intensive yet not very efficient. The other, and perhaps cheaper and costwise more efficient, method of solar energy utilisation is through biological systems such as by growing green plants which are efficient converters of solar radiation. The cellulosic material of plants can then be converted into fuel and chemical feedstock by various methods. The present volume contains a selection from over a hundred papers presented and discussed at the International Symposium on Biological Applications of Solar Energy held at Madurai Kamraj University in December 1978.

The papers cover various aspects —both technological and global—of solar energy utilisation through biological means. They are informative and provide valuable facts and figures about various parameters relevant to the efficient bio-utilisation of solar energy. They also present a wide view of the multifarious approaches being tried out in various parts of the world. There are plenty of charts and diagrams which make the contents easy to grasp. The language should be understandable even to the layman.

The book should serve as a valuable source of information for not only the expert but also for any one interested in energy.

B.B.

**ADVANCED LEVEL MATHEMATICS (Pure and Applied),** *by* C. J. Tranter and C. G. Lambe, *Hodder and Stoughton*, London, (Available from *B. I. Publications*, Promotion Department, 359, Dr. D. N. Road, Bombay-400023). Fourth Edition, 1979, Pp 630, £ 4.25.

MATHEMATICS has lately grown into such an indispensable tool without which almost no branch of science can be properly understood. Even humanities and social sciences are not spared of its use. This subject, usually considered to be quite difficult and 'abstract', scares even good students of other disciplines. To help them use its magnificent techniques and formulae with ease, we need some suitable books on the subject. The book under review is one such book.

The present book written by two Professors of the Royal Military College of Science, Shrivenham, U. K., is divided into 23 chapters and deals with the elements of trigonometry, solid geometry, vectors, matrices, differential and integral calculus, differential equations, statics, dynamics and statistics, apart from some other topics. Each chapter contains quite a large number of solved examples. Units used in the book are those of the Systéme International d'-Unités (SI). The level of the book is such that it may be of use to the students of +2 stage of the new 10+2 system of education, or to the lower level students of our colleges and universities. The book, on the whole, is well written and adequately illustrated.

Alike +2 stage students, candidates appearing in various competitive examinations and non-mathematicians requiring to use the tools of mathematics in their day-to-day professional work will find this book a welcome addition to their shelfs.

NARESH KUMAR

**ORGANIZATION IN PLANTS** (3rd Ed.) *by* W. M. M. Baron, *Edward Arnold (Publishers) Ltd.*, 41 Bedford Square, London (Available from *B. I. Publications*, 359, Dr. D. N. Road, Bombay-4000017) 1979, pp viii + 264, £ 6.75.

EVERY higher plant, and for that matter animal is the sum total of the intricate organization of their cells and tissues into a wonderfully orchestrated whole which is in a state of continuous interaction with its environment. The study of this dynamic interrelationship involves morphological, physiological and ecological approaches. The latest edition of *Organization in Plants* by W.M.M. Baron sets out to examine this fascinating problem. The 264 pages of this volume are grouped into eight chapters besides three appendices.

The chapters touch upon almost all facets of plant life from structural aspects to biochemical events and coordination of activities in the plant. The chapters are profusely illustrated with good line drawings and half-tones, and at the end of each chapter is given a selected list of references. The appendices constitute a very important part of the book. Appendix A comprises a chapterwise list of experimental procedures which can be easily adopted in the class room. Appendix B describes some useful reagents and Appendix C gives a short bibliography on experimental techniques. All things considered, the chapters and appendices would prove very useful to our undergraduate students of botany, and as such this volume deserves wide circulation.

Lest the readers be misled, however, here are some of the errors and drawbacks of the book. To begin with not all the chapters have been dealt with the same depth and competence; some topics are treated very superficially (e.g., Chapter 1 and 8). Further, a couple of errors are simply inexcusable; the wrong depiction of the codon and anticodon (they do not match) in Fig 6.17 (p.133) or the description of *Nitella* as a coenocytic alga (Fig. 5.6, p. 98). At other places it is annoying to find imprecise or ambiguous statements. We are told that the stigma may have "various spines" in *Primula* (p.194); that in tomato "a number of seeds may be shed within the single fruit" (p. 196); and that for most plants to begin sexual reproduction, "there must be sufficient food available to furnish the reproductive parts and swell the seeds (or spores)" (p.189). Another source of irritant to the reader are the wrong references to figures or other parts of the text (Pp. 126, 180, 252). The name of the plant in Fig. 8.12 (p. 188) is given as *Saxifraga longifolia* while the text on next page refers to the same as *S. longiflora*. Errors in spelling or punctuation are not uncommon (Pp. 85, 107, 116, 131, 149, 189, 254, 256). All these could have been easily corrected by better proof reading. I hope in the next edition of this book these would be looked into and the book made more useful.

S. NATESH

**PLUS TWO PRACTICAL PHYSICS** *by* S. Singal, *Tata McGraw-Hill Publishing Co. Ltd.*, 12/4, Asaf Ali Road, New Delhi-110002, pp. xxviii+269, Rs. 19.50.

SINCE ages men of science have explored nature with success on the thesis 'Theory predicts; Experiment decides.' So, experimental skill is a must for steady progress and we must inculcate experimental aptitude in a newcomer to science. Moreover, it helps them to have faith in the validity of established laws and acquire better understanding of physical concepts. The new system of school education has only re-emphasized this contention. Due to profound changes in physics syllabi in this (10+2) pattern, the pace at which new books on this subject have appeared has accelerated. The book in question caters to the need of senior school students and, as such, it is not a very useful addition.

The book is unique in other ways: A. N Puri, formerly of Hindu College, Delhi, notes in the Foreword that "...... the book is self-contained and the treatment is entirely new". The reviewer is inclined to believe that Puri has not gone through the book carefully or has overlooked facts.

The book contains 24 chapters. Organization of chapters is traditional—from vernier to transistor—via specific heat, diffraction grating, air columns, galvanometer and a triode valve; to mention a few. In the beginning, a long list of fomulae, along with symbols, is given. A few tables of physical constants are given at the end of the book. The subject index is also attached.

The author has attempted to expose the subject in a simple language, but it has met its Waterloo. The introductory chapter which deals with 'basics' of practical physics, is, in particular, badly written. Many misleading and conceptually wrong terms have been used. For instance, while discussing "how to draw graphs' the author has replaced the concept of 'independent' and 'dependent' variables by quantities of 'less' and 'more' interest, respectively. One encounters similar amusing nomenclatures and explanations as one proceeds. To our surprise, just one experiment has been discussed as the investigatory project. If my limited knowledge of school curriculum is correct, there is a long list of ten to twelve projects and the reviewer fails to understand how far this book will suffice in this regard.

On the whole, this book lacks cohesiveness, contains many printing errors and needs thorough rewriting. In the present form, it may not serve much purpose.

SURESH GARG

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## Book Received

1. **RAPID READING** *by* G. A. Dudley, *Jaico*, 125, Mahatma Gandhi Rd., Fort, Bombay-400023, Pp. 160, Rs. 12.00.
2. **REMEMERING MADE EASY** *by* Jacqueline Dineon, *Jaico* (address as above), Pp. 96, Rs. 100.
3. **AN INTRODUCTION TO GENERAL RELATIVITY** *by* S. K. Bose, *Wiley Eastern Ltd.*, 4835/24 Daryaganj, New Delhi-110002, Pp. 120, Rs. 25.00
4. **LABORATORY MANUAL IN MOLECULAR GENETICS** *by* Kunthalam Jayaraman and R. Jayaraman, *Wiley Eastern Ltd.*, (Address as above), Pp. 40, Rs. 10.00

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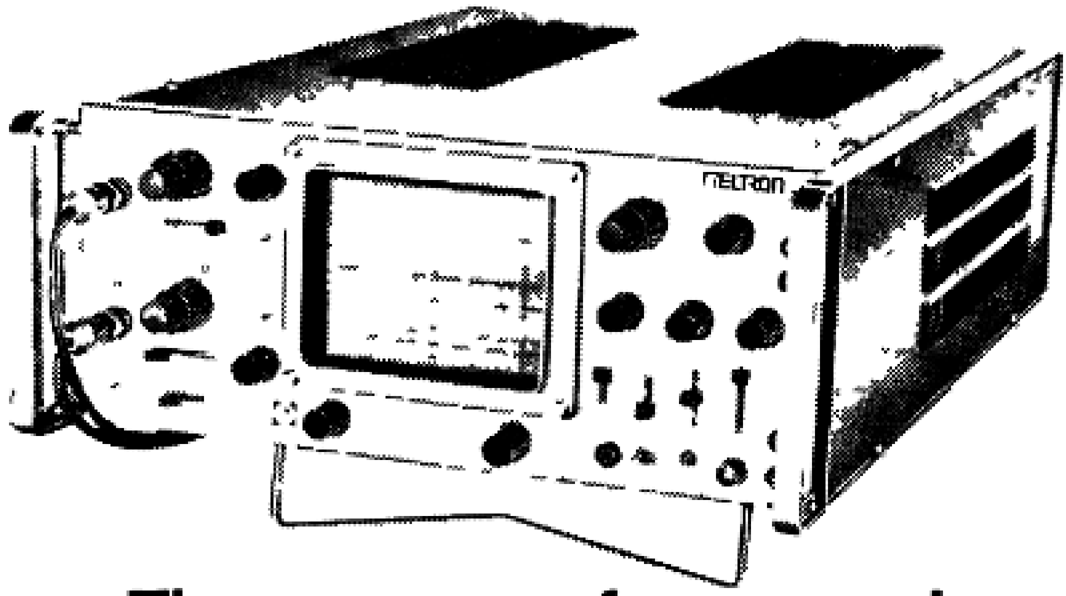

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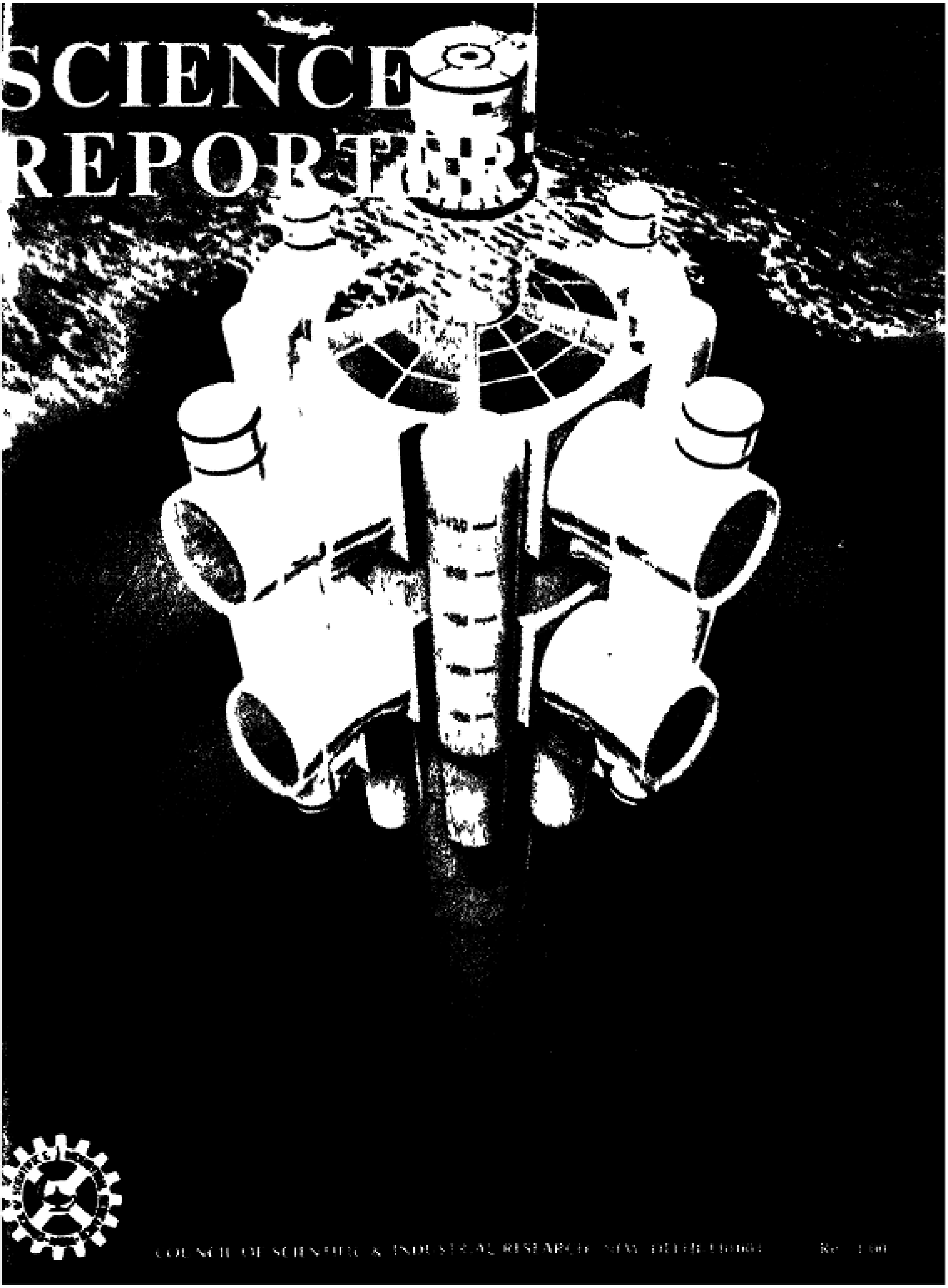

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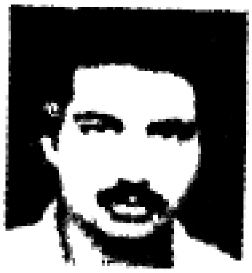

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# SCIENCE REPORTER

VOL. 17 NOVEMBER 1980 NO. 11

696 LETTERS

698 PLANETS AND THEIR POSITIONS—DECEMBER 1980

MAIN ARTICLES

700 Harnessing the ocean heat — *V. Kesava Das*

706 Make your own starfinder — *Biman Basu*

712 Fluorescent X-radiation as an analytical tool — *A. K. Banerjee & S. K. Srivastava*

717 SCIENCE SPECTRUM

The strange case of N-rays—*Cis*-platinum—A new method of cleaning mercury—Non-toxic fungicides—Heterogenous RNA and its role in eukaryotes—Transposon-mutagenesis—Target cells—Hydrologic cycle—How food controls population—A desert shrub with industrial potential

732 NEWS AND NOTES

Nobel Prizes—1980

735 MEDICAL NOTES

Diagnostic enzymes in heart diseases

737 SCIENCE FOR THE YOUNG

G. C. Bhattacharya—X-rays—Brain teasers

742 FOR HER

Cooking for better nutrition

744 SCIENCE IN INDUSTRY

Methane telemonitoring system—Electronic *tala* generator—Nitride-oxinitride bonded silicon carbide

745 TECHNOLOGY FOR VILLAGES

Post-harvest technology

746 BOOK REVIEWS

Vanishing Birds—Asimov on Astronomy—Human and Social Biology

*Cover:* An artist's drawing of OTEC plant proposed by Lockheed Missiles and Space Company, which would generate an estimated 160 megawatts.

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# LETTERS

## Somatostatin and calcaemic hormones

Sir, The article, **Somatostatin and its use in medicine** (*S.R.*, May 1980) by A. Samantsinger was very informative and uptodate. However, I would like to add a point.

The author has mentioned the effects of somatostatin on various endocrine and exocrine glands in the body (p. 328) but nothing has been said about its influences on the calcaemic hormones. Calcitonin (CT) and parathyroid hormone (PTH) regulate calcium metabolism, hence they are called calcaemic hormones. In 1977, S. van Noorden, J. M. Polak and A.G.E. Pearse of the Royal Post-Graduate Medical School, London reported the presence of somatostatin alongwith CT in the thyroid parafollicular C-cells (*Histochemistry*, **53**, 243, 1977) and suggested a role for somatostatin in CT release. But Anthony W. Care and coworkers of the University of Leeds, U.K. and Stewart A. Metz and coworkers of the Veterans Administration Hospital, Washington, raised objection against this suggestion because they could not record any changes in CT and PTH concentrations after somatostatin administration (*J. Endocrinol.*, **77**, 51P., 1978., and *J. Clin.Endocrinol. Metab.*, **57**, 151, 1978, respectively). Recently, Gray K. Hargis and coworkers of the University of Illinois College of Medicine, U.S.A. and Cary W. Cooper and coworkers of the North Carolina University School of Medicine, U.S.A. have clearly demonstrated a marked suppression of CT and PTH concentrations after injection of somatostatin (*Endocrinology*, **102**, 745, 1978 and *Endocrinology*, **104**, 1602, 1979, respectively).

Thus, it can be concluded that somatostatin also inhibits secretion of calcaemic hormones. However, the clinical significance of somatostatin in relation to bone diseases warrants further investigations.

AJAY KUMAR PANDEY
*Department of Zoology*
*University of Gorakhpur*
*Gorakhpur (U.P.) 230001*

## Soma

Sir, I have read with interest the article **Medicines from plants** (*S.R.*, June 1980) by T. Chakraborty and P. Sarkar. The authors have stated, "However, the botanical identity of *Soma*, the divine plant which was used by the Aryans of the Indus Valley (2500 B.C.) to prepare an intoxicating beverage on religious and ceremonial occasions remains a mystery".

Surely, the identity of *Soma* has remained a mystery, because, whosoever has ventured a guess, has approached the problem with a bias that it was an intoxicating drink. All of them have, therefore, gone astray, and named only vague probabilities ranging from *Cannabis sativa* (*bhang*), *Sarocostemma brevistigma*, *Ephedra vulgaris*, etc., to as irrelevant a mushroom as the fly-agaric (*Amanita muscaria*). It was never an intoxicating drink.

*Soma* was a plant from which a potent drink was produced and drunk only at sacrifices and which caused invigorating effects. The plant was pressed between stones, mixed with milk, strained and drunk on the same day. It was never fermented, nor allowed to become alcoholic. *Soma* was drunk by the Aryan warriors before getting into the battlefield for giving them the 'strength of a bull' to fight the enemy. Aryans were turbulent people and had few of the taboos of later India. They were certainly addicted to inebriating drinks of which they had at least two, *soma* and *sura*. *Soma* was drunk at sacrifices and its use was sanctified by religion. *Sura* was purely secular, and was evidently very potent.

The plant must have been available in quantity in the land where the Vedic Aryans performed their sacrifices and it would be a mistake to think that such a plant would have become extinct in the last three millenia or so. The conclusions derived by the multitude of scholars, particularly foreigners, have simply led us astray. It must exist even now. We have not understood the poetic language of the time and only imagined its identity according to the modern botanical terms. They were not botanists to have described the plant (*Soma*) in the language we describe the plants now. In their disgust, some modern interpreters have said that the problem of *Soma* is insoluble. I am sure, it is not insoluble. Only the approach has been wrong.

K. M. BAID
*Forest Botanist*
*26, Trevor Road*
*Forest Research Institute*
*Dehra Dun*

## Wood as a substitute for oil

Sir, The article **Wood as a substitute for oil** (*S.R.*, May 1980) is worth appreciating. Switching over to forest resources for oil will not only be economic but is also easily accessible and tends to promote self-reliance in a developing country like India. We have got suitable manpower, land and technology required for launching such intensive forestry schemes which may give a healthy shape to the Indian economy. But, the much needed change in the attitude of the policy-makers and those who allocate funds to the various wings of development has yet to come up in favour of forestry-oriented schemes.

R. CHOUDHARY
*Indian Forest College*
*Dehra Dun-248006*

### Did a comet kill dinosaurs?

Sir, Dinosaurs have always fascinated man. The mysterious disappearance of these lumbering creatures from terra-firma has been the subject of intense controversy and has spurred the imagination of several theorists. Dilip M. Salwi has lucidly explained the hypothesis that the "sauri" extinction was due to the aftereffects of a meteoric collision (*S.R.*, July 1980). George Gamow in *A Planet Called Earth* has attributed their sudden depletion to a decrease in their birth rate. They perished because the hereditary properties carried over by the genes became more and more "diluted" and gradually grew "tired of division."

Salwi has also referred to the Siberian explosion in 1908 to be due to a comet. The Tunguska blast has baffled scientists. Several theories have been advanced to interpret the incident. A meteor, gas-comet, black hole and anti-matter have been thought to have precipitated the catastrophe. Recently, a claim has been made that the Tunguska holocaust was caused by an ill-fated nuclear-propelled ship from an extra-terrestrial civilization!

S.K. GURTU
*Defence Science Laboratory*
*Metcalfe House*
*Delhi-110054*

### Contraception

Sir, The article on **Menstruation** (*S.R.*, June 1980) was excellent.

The last part of the article —under the heading "Safe period for contraception"—leaves much to be desired. It is stated that : "The success of this (natural) method depends not only on a high degree of motivation and of intelligent understanding of the mechanisms of ovulation but also on a regular menstrual cycle and a reliable means of dating the time of ovulation. All these conditions are difficult to accomplish, or even to comprehend, especially in our country where illiteracy is rampant and hence our inability to exploit this natural way of contraception."

In Patna we have about 6,000 women following a natural method successfully. Most of these women are from families that have a total income of Rs. 400 per month or less. Most of the women are illiterate. Their only motivation is the fact that they do not want to have another baby just now Few, if any, have ever heard of ovulation. Some have regular cycles, some do not. And yet our report for the first half of 1980 shows the following figures:

| | |
|---|---|
| Total number of new acceptors .. | 3,897 |
| Drop outs | 157 |
| Acceptors that wanted to avoid pregnancy . | 3,152 |
| Became pregnant .. | 86 |
| Acceptors that want to achieve pregnancy .. | 745 |
| Became pregnant | 4 |
| Wife illiterate | 3,300 |
| Live in huts in Patna or Bettiah | 2,134 |
| Live in or around Poon Poon, Sokho, or outside of Patna, Bettiah (i e, rural) .. | 1,632 |
| Not marking any kind of chart .. | 2,725 |

Later in the same article the following observation has been made :

"The examination of the vaginal mucus can also give us an indication about the time of the ovulation. If any reliable means can be found out to know the exact time of ovulation, the safe period can be precisely determined".

We pay no attention to ovulation as such. If ovulation occurs, it will generally occur some time during the mucus days. So we teach our acceptors · (1) When mucus begins, abstinence begins, (2) As long as there is mucus there should be abstinence; and (3) When mucus stops abstinence should continue for another three days.

This simple rule is easy to understand. Most couples that have had two or more children find that the abstinence is not too difficult. Of course there are some who prefer the pill, or vasectomy, or tubectomy or abortion. We readily admit that natural family planning is not for all. But most of our acceptors like it. So much so, that when something goes wrong and the wife becomes pregnant, she frequently tells the NFP teacher to drop in and see her once in a while during her confinement and to begin her regular visits after the baby is born.

Kanwar may be interested to know that the solutions to some of his problems have been worked out and that there is an on-going programme embodying these solutions in Patna, not very far from where he lives.

E. VINCENT GALLAGHER, S.J.
*Natural Family Planning*
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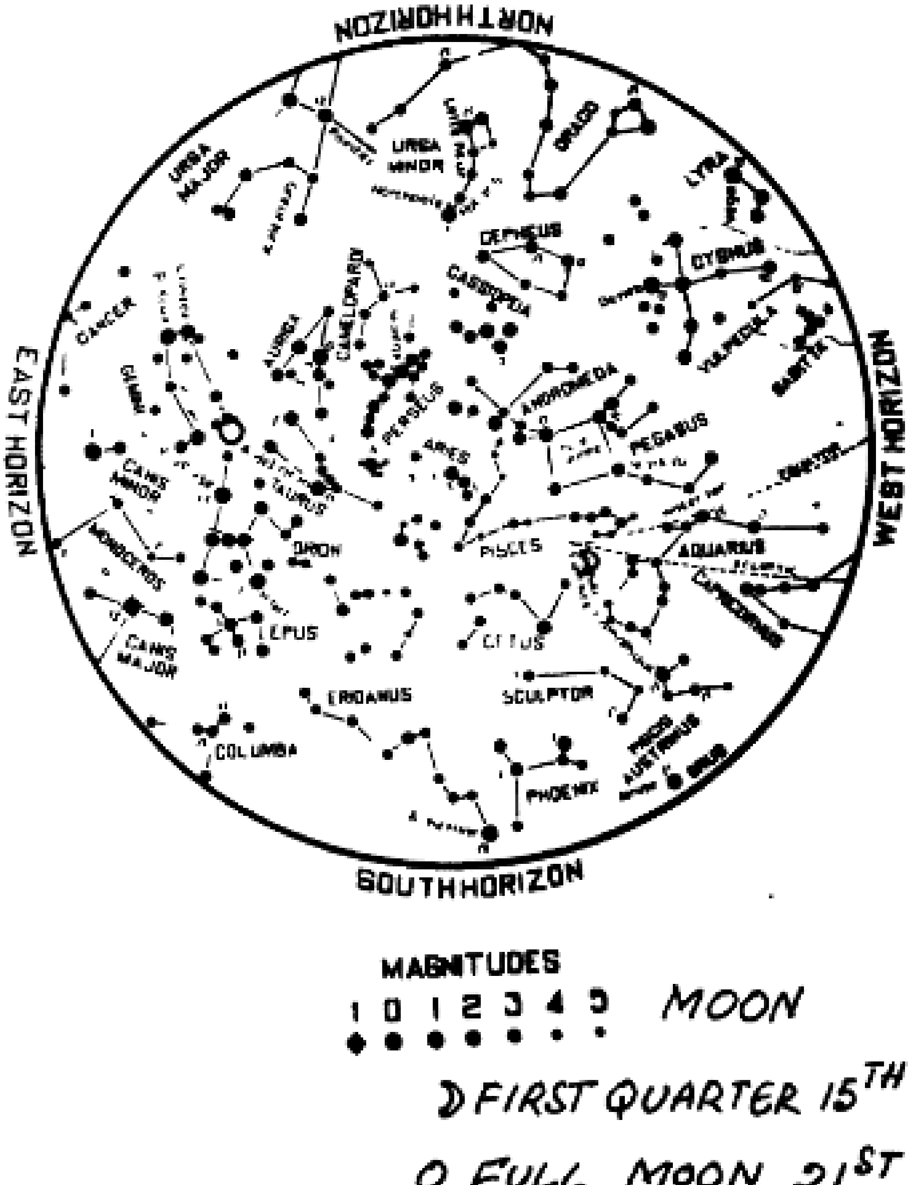
# Planets and their positions

## DECEMBER 1980



### The moon

NEW moon occurs on 7th at 8 05 P M and the full moon on 21st at 11 48 P M I S T

The moon passes three degrees north of Jupiter on 1st about two degrees north of Saturn in the very early hours of 2nd, three and a half degrees north of Venus on 5th about four degrees north of Mercury on 6th three and a half degrees north of Mars on 10th and three degrees north of Jupiter and two degrees north of Saturn on 29th

The lunar crescent becomes first visible after the new moon day in in the evening of 9th In the western part of India, the moon is likely to be visible one day earlier, i e , on December 8th .

The moon is at apogee or farthest from the earth on 3rd and again on 31st, and at perigee or nearest to it on 19th.

The sun is at the winter solstice on 21st

### The planets

**Mercury** (*Budha*), a morning star, rises about an hour before sunrise during the first half of the month. Thereafter, it is too near the sun to be visible. It is in superior conjunction with the sun on 31st. It passes about 5° North of the star Antares (*Jyestha*) on 11th It moves from Libra (*Tula*) to Sagittarius (*Dhanus*) through Scorpio (*Vrischika*) Its visual magnitude is about —0 6 .

**Venus** (*Sukra*), a morning star, rises about two hours before sunrise during the month It passes about 6° North of the star Antares (*Jyestha*) on 25th It moves from Libra (*Tula* to Scorpio (*Vrischika*) Its visual magnitude is about —3 4

**Mars** (*Mangala*), visible in the evening sky, sets about two hours after sunset during the first half of the month and about one and a half hours after it during the second half It moves from Sagittarius (*Dhanus*) to Capricorn (*Makara*) Its visual magnitude is about +1 4

**Jupiter** (*Brihaspati*), visible in the morning sky, rises about one and half hours after local midnight during the first half of the month and about it during the second half It is in quadrature with the sun on 31st It is in Virgo (*Kanya*) Its visual magnitude is about —1 5

**Saturn** (*Sani*), visible in the morning sky, rises about one and a half hours after local midnight during the first half of the month and at about it during the second half It is in quadrature with the sun on 31st It is in Virgo (*Kanya*) Its visual magnitude is about +1 0

(*Source* Director, Positional Astronomy Centre, India Meteorological Deptt . New Alipore, Calcutta 700053)

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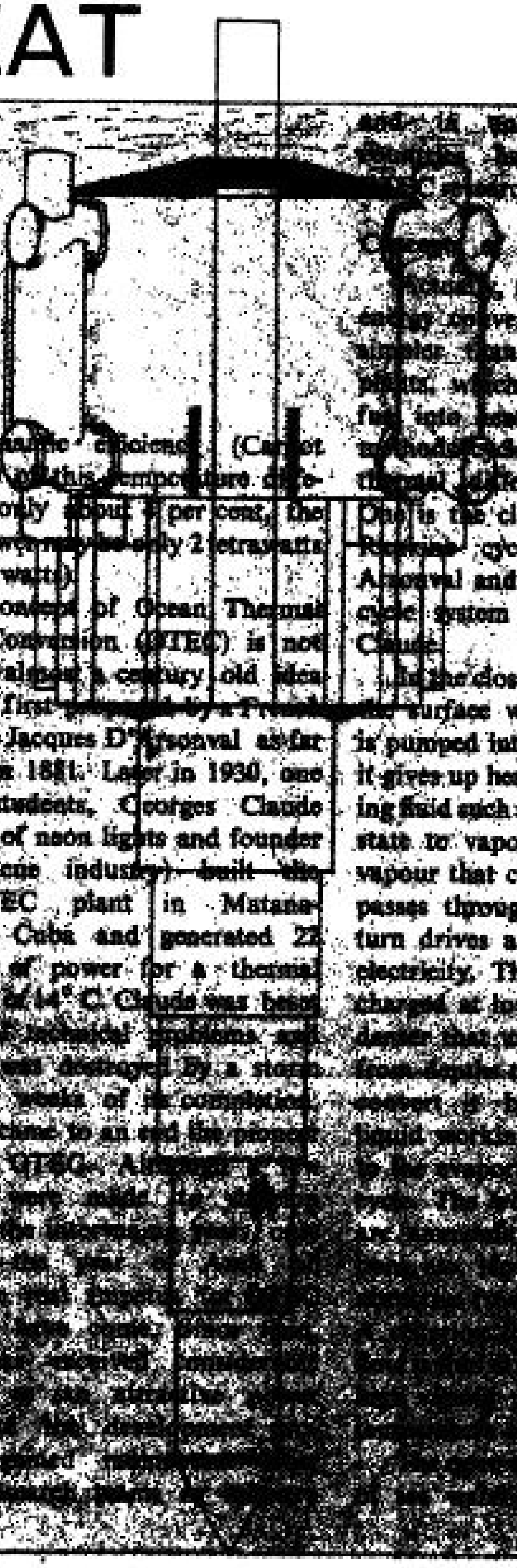
# HARNESSING THE OCEAN HEAT

**Solar energy, collected and stored in the thin surface layers of the ocean, would produce about 10[illegible] watts of clean power in one second. OTEC is meant to tap this immense energy**



### V. KESAVA DAS

IN the present energy crisis, it is not only sensible but vital to explore all possible avenues of new energy sources. Thermal energy from sea is a clean and renewable energy source. The sea surface is the largest natural collector of solar energy and it is well-known that the ocean is thermally stratified, i.e., temperature decreases with depth. Sun's energy is collected and stored in the thin surface layers of the tropical and subtropical oceans which, if released in one second, would produce about 10[illegible] watts of power. Surface water of the oceans is warmer by 20°C-25°C than the underlying waters at depths of about 1000 m (Fig. 1). This thermal difference persists in the oceans because of little conduction and mixing from surface to bottom. The thermal gradient thus prevailing can be utilized for generating power. It is estimated that for a temperature difference of 12°C, the power available in the tropical oceans is about 50 terawatts (5 × [illegible] watts). The energy density level of this temperature difference is equivalent to 210 m hydraulic head and it is about [illegible] m for a temperature difference of 20° C. Since the thermodynamic efficiency (Carnot efficiency) of this temperature difference is only about [illegible] per cent, the usable power [illegible] only 2 terawatts ($2 \times 10^{12}$ watts).

The concept of Ocean Thermal Energy Conversion (OTEC) is not new. It is almost a century old idea as it was first [illegible] by a French physicist, Jacques D'Arsonval as far back as in 1881. Later in 1930, one of his students, Georges Claude (inventor of neon lights and founder of acetylene industry) built the first OTEC plant in Matanzas Bay, Cuba and generated 22 kilowatts of power for a thermal difference of 14° C. Claude was beset by several technical problems, and his plant was destroyed by a storm after two weeks of its completion and thus came to an end the pioneer work in OTEC. A[illegible] attempts were made [illegible] OTEC in the [illegible] In 197[illegible] [illegible] OTEC [illegible]

[illegible] and in universities in several [illegible] have been engaged in [illegible] research and development.

[illegible] energy conversion

[illegible] fuel-free ocean thermal energy conversion power cycles are simpler than conventional power plants, which require conversion of fuel into heat. There are two basic methods (cycles) for converting ocean thermal difference into electricity. One is the closed cycle (well-known Rankine cycle) proposed by D' Arsonval and the other is an open cycle system employed by George Claude.

In the closed cycle system (Fig. 2) the surface warm water in the sea is pumped into an evaporator where it gives up heat to evaporate a working fluid such as ammonia from liquid state to vapour. The high pressure vapour that comes out of the boiler passes through a turbine which in turn drives a generator to produce electricity. The vapour is then discharged at low pressure into a condenser [illegible]

---

Sh. Kesava Das is with the Physical Oceanography Division, National Institute of Oceanography, Dona Paula, 403 004, Goa fluid. The sea water is flash evaporated under partial vacuum by reducing the pressure to 1/30 atmosphere in an evaporator. The ocean surface temperature is adequate for this purpose. The low pressure steam thus produced drives a turbine which is connected to an electrical generator. The spent steam is then cooled in a condenser by the cold water pumped from below. The obvious difference from closed cycle is that in this cycle the condensate is not recycled contrary to what is done in the case of closed cycle, thus deriving the name 'open cycle'. Since Claude employed this method, it is also known as Claude Cycle. The condensate can be used as desalinated water if a surface condenser is used. If a spray condenser is used, the condensate can be mixed with the cooling water and the mixture can be discharged back into the ocean.

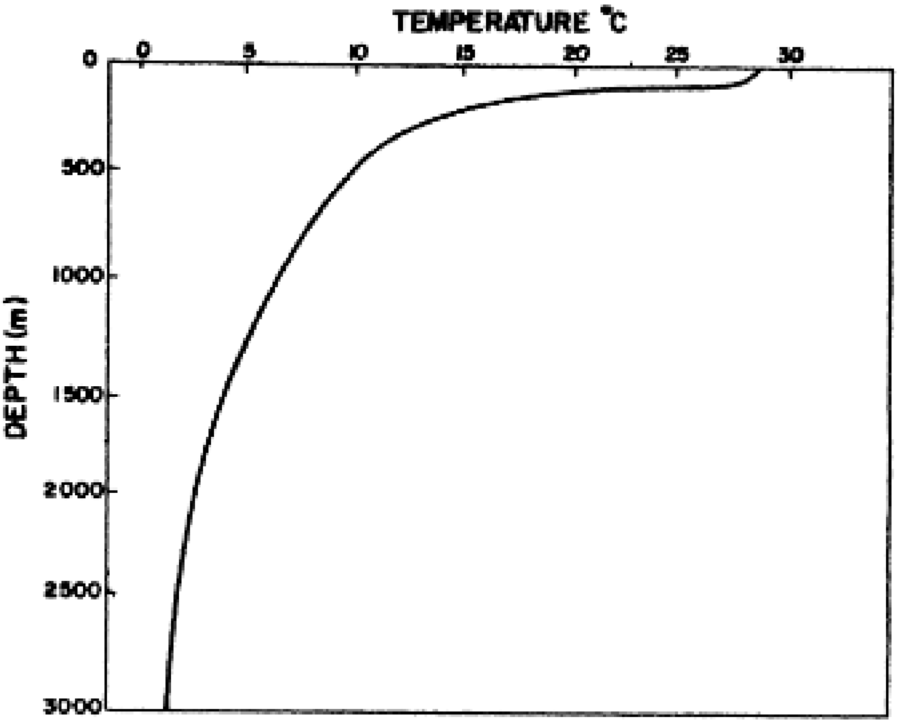


Fig. 1. A typical temperature profile in the tropical sea

Both the closed and open cycle systems hold promise for commercial applications. However, the state of development of open cycle technology is less advanced than that of closed cycle. Although simple in concept, the open cycle system requires extremely large turbines and large pipes because of the low pressure. Furthermore, degasifiers are needed to remove gases dissolved in sea water and there will be large losses of efficiency. Some modifications are suggested to avoid these requirements, but retaining its simplicity and other advantages. One such technique suggested by Earl J. Beck of Naval Construction Battalion Center, California, U.S.A. (1975), operates on the principle of the well-known air-lift pump. The air is replaced by the vapour of the water itself. He proposed the introduction of the warm surface water through a restriction in the lower end of a vertical pipe. The resulting cavitation would provide the necessary nucleation for the formation of steam bubbles, which in a two phase mixture in the vertical pipe would provide the gravity head to elevate the water well above the ocean surface. An advantage of this approach is that as the hydraulic head is produced, a hydraulic turbine can be used in place of gas turbine. Instead of bubbles, another approach favours formation of a sea water foam, while yet another uses warm sea water as a mist.

On the other hand, the closed cycle system requires extensive heat exchanger surfaces to transfer large amounts of heat at the low temperature differences that are being exploited. The heat exchangers (evaporator and condenser) must transfer heat effectively. Biofouling and corrosion of the heat exchangers affects the performance of heat transfer. Several biofouling counter measures are under investigation, including both mechanical and chemical cleaning. It is to be noted that the biofouling problem is minimum in the open cycle system since there are no heat transfer requirements in the evaporator.

The essential major components of an OTEC plant are : (1) an evaporator fueled by warm sea water to change the state of the working fluid from liquid to gas; (2) a turbine to convert the thermal energy stored in the working fluid into mechanical energy to drive; (3) an electric generator; (4) a cold water pipe and pumping system to upwell the cold deep water to feed into; (5) a condenser to liquefy the low pressure gas; and (6) pumps to circulate the working fluid from condenser to evaporator and to pressurize the liquid.

## Operational factors

As the thermodynamic efficiency of the OTEC system is only a few per cent, enormous quantities of sea water must be passed through the plant to extract energy. Since the water is available in plenty, the process is considered viable. Moreover, it may be possible to capitalize on the idea of a perpetual "saltfountain" put forward by H. Stommel, A.B. Arons, and D. Blanchard, (USA) in

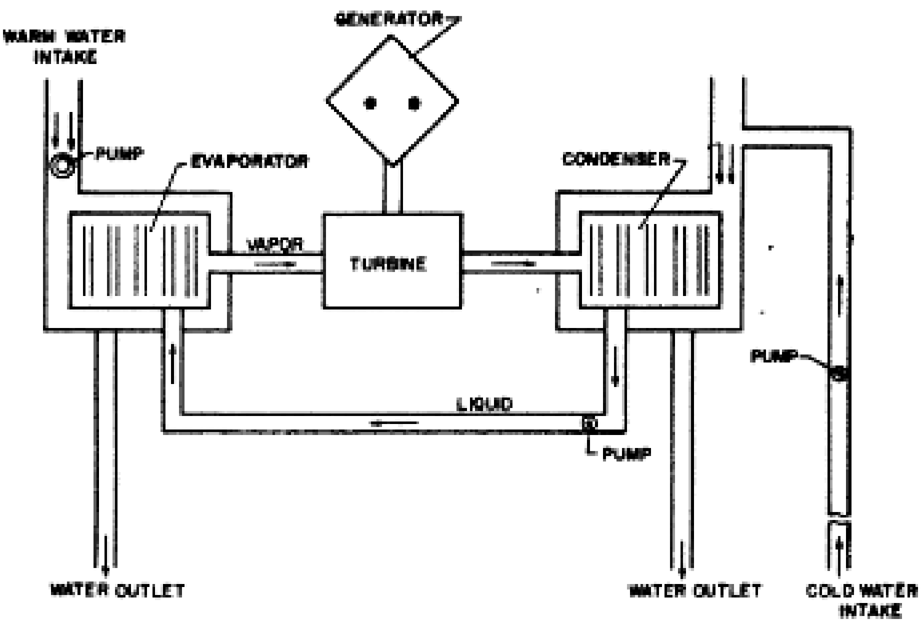


Fig. 2. Schematic diagram of closed cycle system

1955; that once the water is pumped either up or down through a pipe inserted vertically in the sea, the water continues to flow in the direction of pumping without additional effort or even after the pumps are put off. This occurs because of the density changes (density becomes less in the case of rising water and more in the reverse case) caused by sea water where heat diffuses 100 times faster than salt. Hence for reasons of density stratification, water flows vertically through a pipe forever in the direction in which it was initially pumped.

Thermal perturbations could affect the optimum performance of the plant. For example, recirculation of warm or cold water effluents into the warm water intake could lower the temperature there. The plant's output would be reduced as the power output is roughly proportional to the square of the available temperature difference. Similarly utilization of thermal gradient in one location may constrain the potential resource available downstream depending upon how thermal effluents are discharged.

## Options of delivery

There are two basic options open for utilizing OTEC electrical power generated at sea. The first option is to transmit the electricity to the shore through submarine cables. This is possible at sites fairly close to the shore. The other concept envisages manufacturing of energy-intensive products aboard the plant. The products could be such as ammonia, hydrogen, aluminium, chlorine, magnesium, carbon dioxide, methanol, etc. Some of the products could provide fertilizers and fuels or serve as a means to convey electricity to shore. For example, ammonia can be produced by using hydrogen generated from sea water through electrolysis process in combination with nitrogen extracted from the atmosphere. And ammonia can be regarded as a hydrogen carrier that may be easily transported, stored and then decomposed when wanted into hydrogen plus inert nitrogen. Hydrogen can then be combined with oxygen in fuel cells to produce electricity. The first option requires mooring and precise positioning of the OTEC platform whereas the second option does not. An advantage of the second option is that the products could be transported to the shore by ships. Also it could be pursued wherever adequate thermal sources are available irrespective of the proximity to the shore, since underwater cabling is not required.

Two important extra benefits of OTEC plant are the promotion of sea farming by enriching surface waters by nutrients contained in water

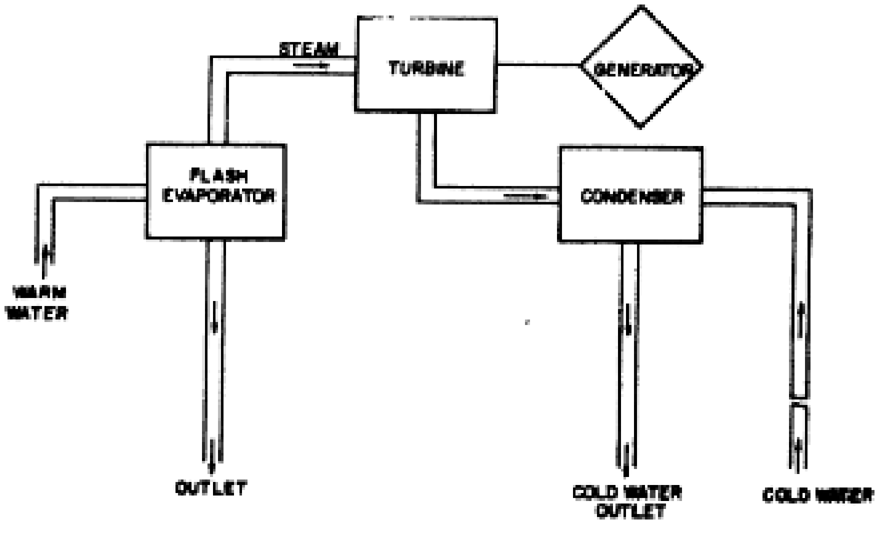


Fig. 3. Schematic diagram of open cycle system

pumped from below, and the possibility of fresh water supply. Another use of OTEC power is an aluminium refining plant at tropical sites close to bauxite reserves as in Jamaica and Indonesia.

## Types of plants

Various platform configurations have been considered for commercial power plants, including ship shapes and submersibles such as spar buoys. Since the platform and barge-shaped plants have their superstructure above the sea surface, they are likely to be shuffled by waves and storms. The submersible types, where like an iceberg most of the structures are below the surface, are free from waves and storms. Both the types are under development. The choice depends on the site of the plant, cost effectiveness, etc. A key feature of the ocean system of OTEC power plants is the vertical deployment of cold water pipes (hundreds of meters long). Two approaches have been suggested for this purpose. One is the float and flip technique where pipe is towed to OTEC station and flipped into position. The other technique which is similar to the drilling procedure is to deploy pipe section by section.

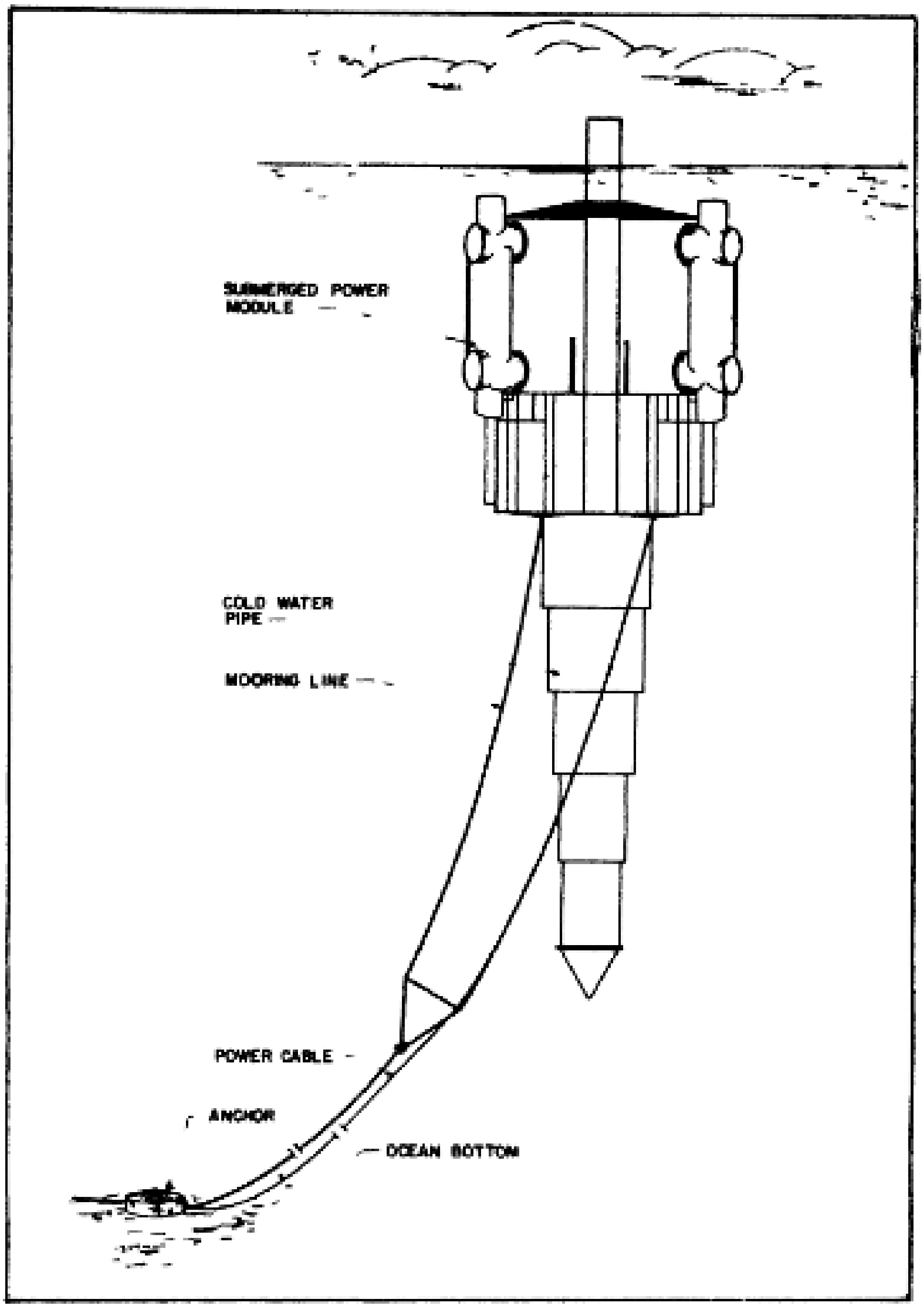


Fig. 4. Schematic diagram of a submersible type of OTEC plant

## Environmental impact

The operation of OTEC plant may modify the physical, biological and chemical characteristics of its environment. The thermal effluent discharge of a plant could reduce the temperature of its environment that could possibly affect the local climate. However, appropriate discharge of the thermal effluents would limit temperature decrease to a small fraction of a degree celsius. It is not yet certain how far the large scale OTEC operations will affect the global sea surface and subsurface temperature. If the thermal energy is extracted at the level of $10^{13}$ watts, it is roughly predicted that the ocean surface layer would be cooled by about 1° C. Here it must be pointed out that some investigators have estimated that a 2° C drop in world average temperature would precipitate a glacial readvance. If true, this would place an upper limit of ocean thermal energy conversion at about $10^{13}$ watts level. However, some claim that the heat taken out of the surface water is regularly renewed by short wave solar radiation. Nevertheless, the heat radiated at night from the sea surface into the atmosphere is likely to be reduced.

Another environmental hazard involves the global increase in $CO_2$ in the atmosphere. It has been speculated that OTEC operations would increase atmospheric $CO_2$ by bringing cold $CO_2$-rich water upwards to lower pressure environment and allowing it to escape into the atmosphere. However, another school claims that OTEC operation might enhance the rate of $CO_2$ absorption in the sea from the atmosphere as a result of more photosynthesis taking place in the presence of more nutrients added to the surface waters through the discharge of deep water.

Yet other environmental concerns include impingement and entrainment of biota, possible discharge of biocides, corrosion products and working fluids, artificial reef, nesting and migration impacts on the marine organisms. These problems can be controlled to a large extent by proper management and technical advancement.

On the other hand, compared to other conventional power plants such as nuclear or fossil fuel plants, OTEC does not offer any potential hazard as it produces no radioactive waste and releases no particulate matter or obvious pollutants into atmosphere or oceans. Hence OTEC seems almost devoid of potential adverse environmental effects.

### Development programme

A considerable amount of OTEC development activities are going on in several countries like the USA, France, Japan, etc. For example, US Government budget for OTEC programme was $38 million dollars during the fiscal year 1979. A 50 kilowatt OTEC barge mounted pilot plant went into operation in August 1979, near the island of Hawaii in the Pacific Ocean. The setting up of a large number of OTEC power plants for commercial applications will require significant capital investment. However, from a net energy standpoint, the pay back time for an OTEC plant seems favourable—about a year. In India, besides the islands in Bay of Bengal and Arabian Sea, more favourable sites for OTEC plants are on the east coast of India than the west coast because the continental shelf is wider on the west coast than the east coast. However, not much attention seems to be given to the OTEC in India. Nonetheless, it is learnt that Tamil Nadu State Electricity Board is undertaking a feasibility study on OTEC plant on Madras coast.

Of all the solar energy options now under study, OTEC is the only one that does not require thermal energy storage because the ocean itself is a storage reservoir, and offers a base load option in contrast to the wind power or solar power plants employing artificial collectors since the ocean thermal difference is a constant source of energy facilitating continuous day and night operation. Each megawatt of base-load oil-derived electricity for which OTEC power can be substituted is equivalent to about 40 barrels of oil per day. Because of the location of the world ocean thermal source (25° N to 25° S), it may be available to many islands and developing countries. For inhabited islands in the world oceans, OTEC appears to be a boon, for many of them do not generate electricity for want of sources. The greatest advantage of OTEC plants is that technical breakthroughs are not needed to build and operate them and that OTEC can be implemented with the available technology and materials. The existing offshore technology in the field of oil exploration serves as a stepping stone to OTEC development.

In a global situation where conventional energy reserves are depleting and the cost is skyrocketing, ocean thermal energy provides a potential alternative as an economically attractive, least polluting and renewable source of energy. It is hoped that ocean thermal power will be available by the turn of this century to supplement the existing power supplies and will help in extending the life of non-renewable fuel sources.

### Further reading

1. Richards, Adrian F. (1976), Extracting energy from the oceans, a review, *Mar. Tech. Soc. J.*, 10 (2) p 5-24.
2. Beck, E.J. (1975), Ocean thermal gradient hydraulic power plant, *Science*, 189, p. 293-294.
3. Cohen, Robert (1979), Energy from the ocean thermal gradients, *Oceanus*, 22 (4), p. 12-22.
4. Fuller, R.D. (1978), Ocean thermal energy conversion, *Ocean Management*, 4 (2,3,4) p. 241-258.
5. Hagen, Arthur W., *Thermal energy from the sea* (1975), Mays Data Corporation, New Jersey, p. 150.

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## FOR HER (*Continued from page* 743)

preserving the nutrients in vegetables is to steam them (and consume them immediately afterwards). Similarly rice is best cooked by steaming with just the required amount of water. The quantity of water used for washing the rice should also be the minimum possible lest the minerals and vitamins such as the B vitamins (thiamine and nicotinic acid) are leached out.

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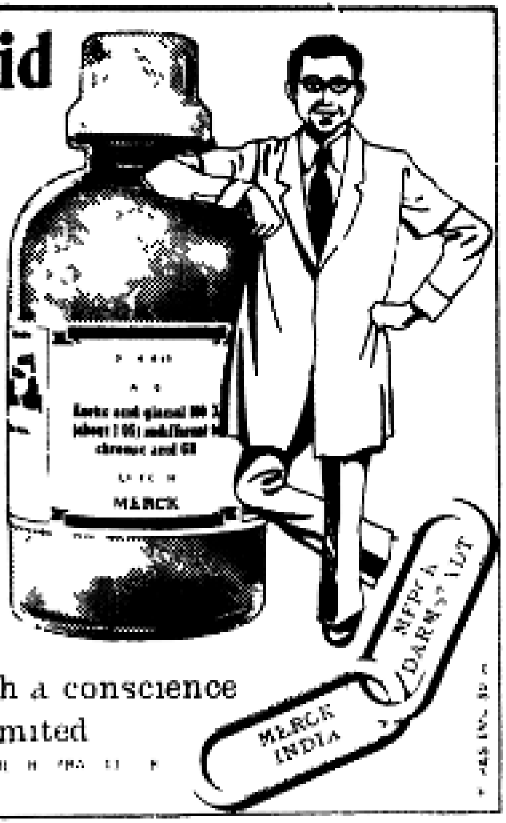

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The working principle of the Starfinder is simple. It is based on the fact that the positions of stars and constellations in the night sky at any particular hour on any specific date is always the same regardless of the year. For example, if you find the star Alphertz in constellation of Pegasus (see *S.R.* Aug. 1979, p. 574) overhead at 9 p.m. on 15th November this year, it will be so every year at 9 p.m. on 15th November.

The second guiding principle here is the slow but steady westward 'movement' of the constellations night after night. Every night the stars and constellations rise in the east four minutes earlier than on the previous night. This means that they 'gain' 2 hours in a month. Over a year, the gain is a full 24 hours so that the constellation pattern on any night becomes the same at the end of the year. The third point to remember here is that in an hour the constellation pattern moves westward by 15°.

All these factors are taken into account in designing this simple Starfinder. Essentially it consists of two dials—one of which we may call the Right Ascension dial (Fig. 2) and the other the Declination dial (Fig. 3). Along the outer rim of the RA dial are marked dates along with months of the year. Next to month scale is another circle which shows Right Ascension values from 0h 0m to 23h 50m. Each hour division is further subdivided into 10-minute segments. The important point to note here is that the 0h 0m mark of the RA scale falls just below the date September 23 marked on the outermost scale

The RA dial is fixed on a board which has a semicircular scale marking the 'local time' from 6 p.m. to 6 a.m (Fig. 1). Mounted at the centre of the RA dial is an upright bracket which holds the Declination dial and the starsight. The Declination dial is a simple semicircular scale marked in degrees as shown in Fig. 3. When the Declination dial is set at 0° the starsight points exactly to the celestial equator.

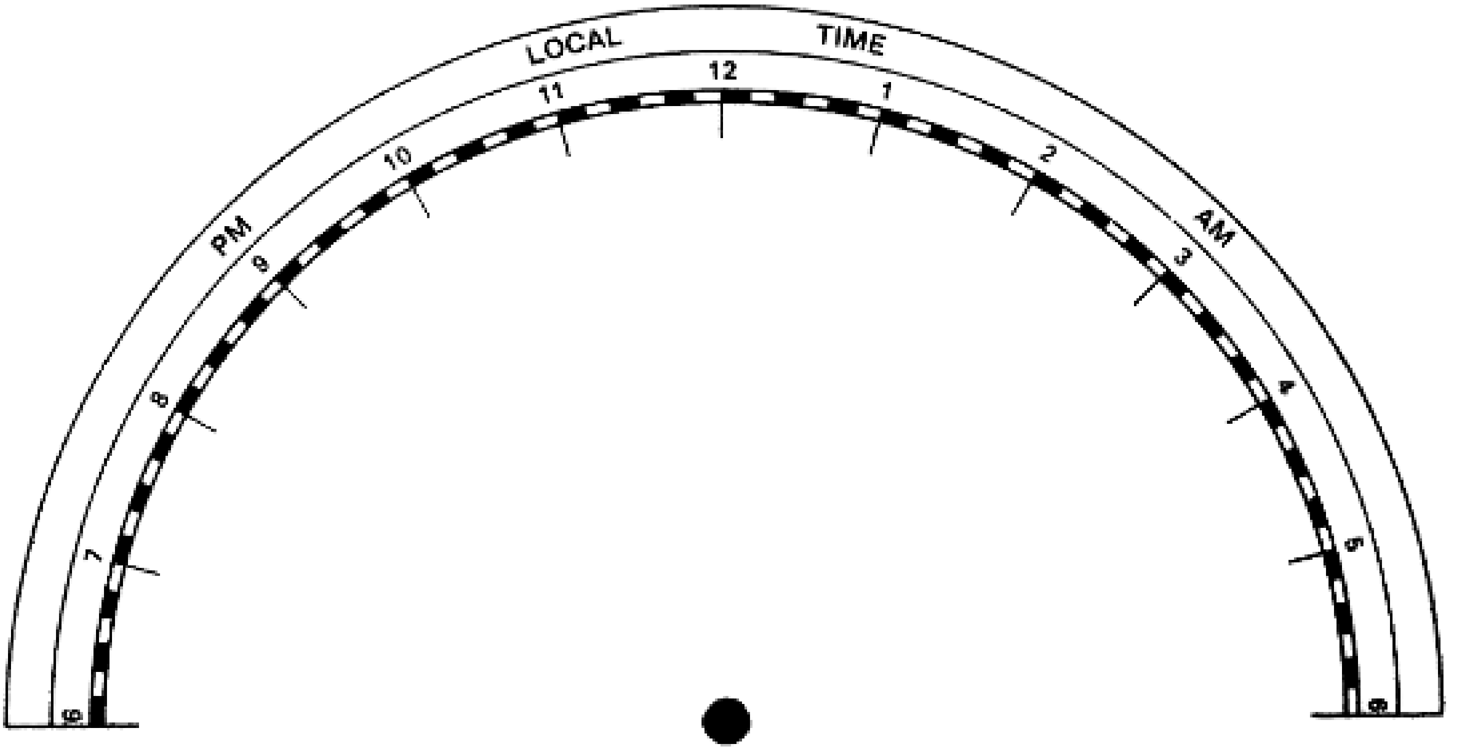

Fig. 1

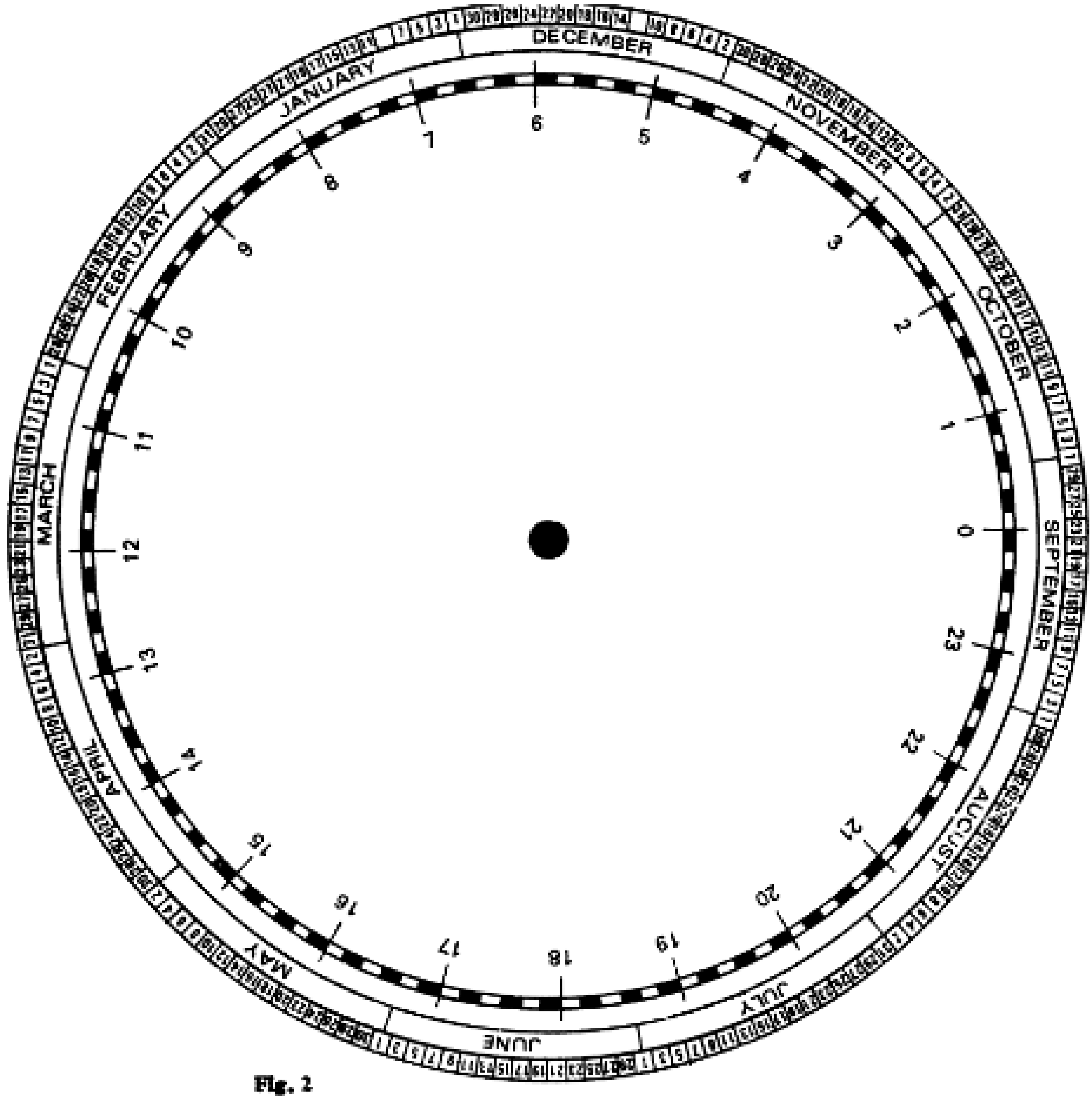

Fig. 2

The assembly of the Starfinder is shown in detail in Fig. 4. The RA dial is fixed to a base board held at an angle with the horizontal equal to 90° minus the latitude of the place of use (Table 1). On the base board is marked a line which should be aligned with the north-south direction before using the instrument. The starsight is fitted at the end of a long tube or wooden dowel to clear the base of the instrument. (This is necessary for viewing stars near the zenith.)

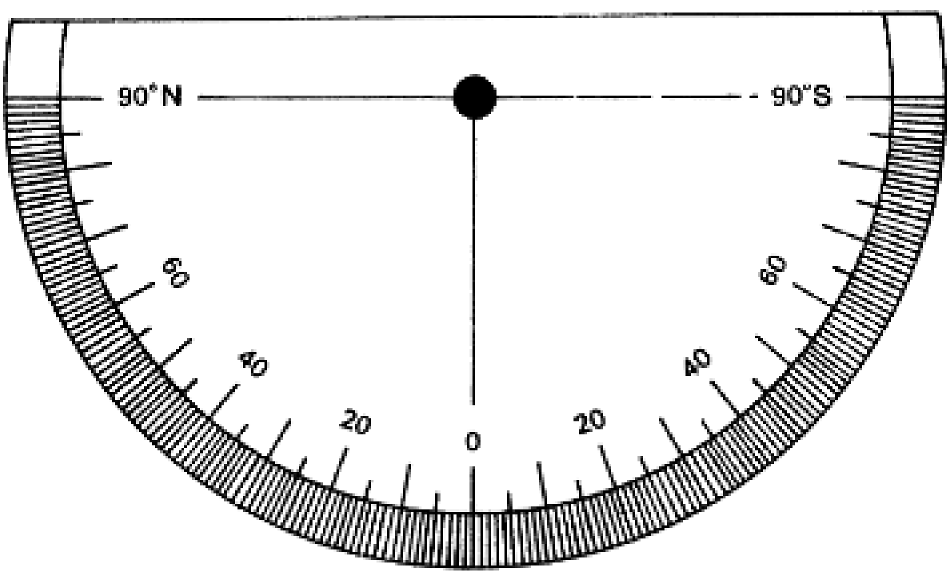

Fig. 3

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### Table 1. Correction factors for selected towns

| *Town* | *Latitude** *(Degrees North)* | *Longitude** *(Degrees East)* | *Correction Factor (Minutes)* | *Town* | *Latitude** *(Degrees North)* | *Longitude** *(Degrees East)* | *Correction Factor (Minutes)* |
|---|---|---|---|---|---|---|---|
| Agartala | 23.5 | 91.0 | +34 | Jodhpur | 26.0 | 73.0 | 38 |
| Agra | 27.0 | 78.0 | 18 | Kanpur | 26.5 | 82.0 | 2 |
| Ahmedabad | 23.0 | 72.5 | 40 | Kharagpur | 22.0 | 87.0 | +18 |
| Aijal | 23.5 | 92.5 | +40 | Kohima | 25.5 | 94.0 | +46 |
| Ajmer | 26.5 | 74.5 | 32 | Kozhikode | 11.0 | 75.5 | 28 |
| Aligarh | 27.5 | 78.0 | 18 | Kurnool | 15.5 | 78.0 | 18 |
| Allahabad | 25.5 | 81.5 | 4 | Lucknow | 26.5 | 80.5 | 8 |
| Amravati | 20.5 | 77.5 | 20 | Madras | 13.0 | 76.5 | 24 |
| Amritsar | 31.5 | 74.5 | 32 | Madurai | 9.5 | 78.0 | 18 |
| Asansol | 24.0 | 87.0 | +18 | Mangalore | 12.5 | 74.5 | 32 |
| Aurangabad | 19.5 | 75.0 | 30 | Meerut | 28.5 | 77.5 | 20 |
| Bangalore | 12.5 | 77.5 | 20 | Mussoorie | 30.5 | 78.0 | 18 |
| Bareily | 28.0 | 79.5 | 12 | Mysore | 12.0 | 76.5 | 24 |
| Baroda | 22.0 | 73.0 | 38 | Nagpur | 21.0 | 79.0 | 14 |
| Bhavnagar | 21.5 | 72.0 | 42 | Naini Tal | 29.0 | 79.0 | 12 |
| Bhopal | 23.0 | 77.0 | 22 | Ootacamund | 11.0 | 76.5 | 24 |
| Bikaner | 28.0 | 73.0 | 38 | Panaji | 15.5 | 73.5 | 36 |
| Bombay | 18.5 | 72.5 | 40 | Patiala | 30.0 | 76.0 | 24 |
| Calcutta | 22.5 | 88.0 | +22 | Patna | 25.5 | 85.0 | +10 |
| Chandigarh | 30.5 | 76.5 | −24 | Pondicherry | 11.5 | 79.5 | 12 |
| Cochin | 9.5 | 76.0 | 26 | Port Blair | 11.5 | 92.5 | +40 |
| Coimbatore | 11.0 | 76.5 | 24 | Pune | 18.5 | 73.5 | 36 |
| Cuttack | 20.5 | 85.5 | 12 | Puri | 19.5 | 85.5 | +12 |
| Darjeeling | 27.0 | 88.0 | +22 | Raipur | 21.0 | 81.5 | 4 |
| Dehra Dun | 30.0 | 78.0 | 18 | Rajkot | 22.0 | 70.5 | 48 |
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| Gaya | 24.5 | 85.0 | +10 | Simla | 31.0 | 77.0 | 22 |
| Gulbarga | 17.0 | 76.5 | 24 | Srinagar | 34.0 | 74.5 | 32 |
| Gwalior | 26.0 | 78.0 | 18 | Trivandrum | 8.5 | 76.5 | 24 |
| Hyderabad | 17.0 | 78.5 | 16 | Udaipur | 24.5 | 73.5 | 36 |
| Imphal | 24.5 | 93.5 | +44 | Ujjain | 23.0 | 75.5 | 28 |
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| Jhansi | 25.5 | 78.5 | 16 | Warangal | 18.0 | 79.5 | 12 |

*Rounded up to the nearest half degree

## Using the Starfinder

The first step in using the Starfinder is to align the instrument with the true north-south direction. For this a magnetic compass will be required. The next thing is to set the latitude angle correctly. For this a wooden wedge is the simplest to use. Make a wedge with a base angle equal to 90° minus the latitude of your place (Table 1). The wedge is inserted between the two boards forming the base of the instrument (Fig. 4).

Once you have set the Starfinder in a true north-south direction and set the latitude angle correctly, you can go ahead with finding any star. But before you can do this you will need the correct 'local time' of your place, because the working of the Starfinder is based on that. You can easily find your local time from the Indian Standard Time (IST) if you know your longitude. Remember that the IST is based on longitude 82.5 E. This means that for any place with longitude 82.5 E the local time will be the same as the IST. But for places east or west of longitude 82.5°E, a correction will have to be made to get the local time.

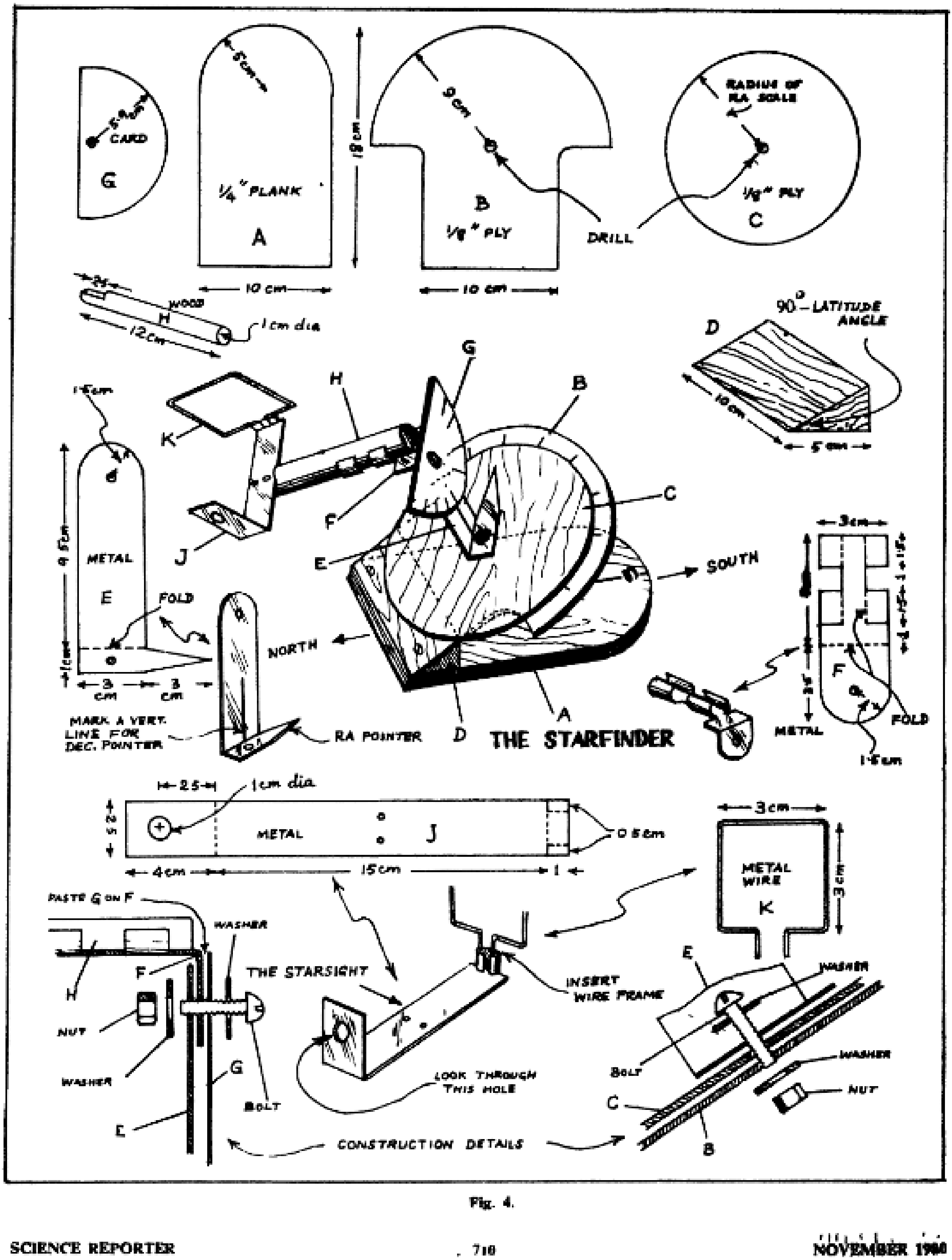

5 cm
CARD
G
5 cm
1/4" PLANK
A
18 cm
10 cm
9 cm
B
1/8" PLY
10 cm
RADIUS OF RA SCALE
1/8" PLY
C
DRILL
2.5
WOOD
H
12 cm
1 cm dia
90° – LATITUDE ANGLE
D
10 cm
5 cm
G
H
B
K
F
C
E
J
SOUTH
NORTH
D
A
THE STARFINDER
1.5 cm
9.5 cm
METAL
E
FOLD
1 cm
3 cm
3 cm
MARK A VERT. LINE FOR DEC. POINTER
RA POINTER
3 cm
1.5
1
1.5
1
4
3.5
F
METAL
FOLD
1.5 cm
2.5
1 cm dia
2.5
METAL
J
0.5 cm
4 cm
15 cm
1
3 cm
METAL WIRE
K
3 cm
PASTE G ON F
WASHER
H
F
NUT
WASHER
G
E
BOLT
THE STARSIGHT
INSERT WIRE FRAME
LOOK THROUGH THIS HOLE
E
WASHER
BOLT
WASHER
NUT
C
B
CONSTRUCTION DETAILS

Fig. 4.

### Table 2. Coordinates of prominent stars

| *Star* | *Constellation* | *Magnitude* | *RA* | *Declination* |
|---|---|---|---|---|
| Achernar | Eridanus | 0.60 | 1h 40m | 57.0°S |
| Acrux | Crux | 1.58 | 12h 30m | 62.5°S |
| Aldebaran | Taurus | 1.06 | 4h 30m | 16.5°N |
| Algol | Perseus | variable | 3h 10m | 40.5°N |
| Alkaid | Ursa Major | 1.91 | 13h 50m | 49.0°N |
| Altair | Aquila | 0.89 | 19h 50m | 8.5°N |
| Antares | Scorpius | 1.22 | 16h 30m | 26.0°S |
| Alioth | Ursa Major | 1.68 | 12h 50m | 56.0°N |
| Bellatrix | Orion | 1.70 | 5h 20m | 6.0°N |
| Betelgeuse | Orion | 1.00 | 5h 50m | 7.0°N |
| Canopus | Carina | —0.86 | 6h 20m | 52.5°S |
| Capella | Auriga | 0.21 | 5h 20m | 45.5°N |
| Castor | Gemini | 1.99 | 7h 30m | 31.5°N |
| α-Centauri | Centaurus | 0.06 | 14h 30m | 60.5°S |
| Deneb | Cygnus | 1.33 | 20h 40m | 45.0°N |
| Dubhe | Ursa Major | 1.95 | 11h 00m | 61.5°N |
| El Nath | Taurus | 1.78 | 5h 30m | 28.5°N |
| Fomalhaut | Piscis Australis | 1.29 | 23h 00m | 29.5°S |
| Kaus Australis | Sagittarius | 1.95 | 18h 20m | 34.0°S |
| Mirphak | Perseus | 1.90 | 3h 20m | 49.5°N |
| Pollux | Gemini | 1.21 | 7h 40m | 28.0°N |
| Procyon | Canis Minor | 0.48 | 7h 40m | 5.0°N |
| Regulus | Leo | 1.34 | 10h 10m | 12.0°N |
| Rigel | Orion | 0.34 | 5h 10m | 8.0°S |
| Schaula | Scorpius | 1.71 | 17h 30m | 37.0°S |
| Sirius | Canis Major | -1.58 | 6h 40m | 16.5°S |
| Spica | Virgo | 1.21 | 13h 20m | 11.0°S |
| Vega | Lyra | 0.14 | 18h 40m | 38.5°N |

### Table 3. Coordinates of some star clusters and nebulas

| *Object* | *Magnitude* | *RA* | *Declination* |
|---|---|---|---|
| Andromeda Galaxy (M31) | 4.8 | 0h 40m | 40°N |
| Hyades cluster | 0.6 | 4h 20m | 15.5°N |
| Orion Nebula (M42) | 3.8 | 5h 30m | 6.0°S |
| Plaiades cluster (M45) | 1.3 | 3h 40m | 24.0°N |
| Praesepe cluster (M44) | 3.7 | 8h 40m | 20.0°N |

The correction factor can be calculated easily because it is known that 15° of longitude is equivalent to 1 hour, or 60 minutes, of time. This means that each degree of longitude is equivalent of 4 minutes of time. To find the local time at your place you have simply to add (if you are east of 82.5°E) or subtract (if you are west of 82.5°E) the requisite number of minutes to or from the IST depending upon your longitude. For example, if you are in Delhi (long. 77°E), to find your local time you have to *substract* (82.5 − 77) × 4 = 22 min. to the IST. For Calcutta (long. 88°E) the factor is (88 − 82.5) × 4 = 22 min., that is, you will have to *add* 22 minutes to the IST to get the local time. A list of correction factors for important towns is given in Table 1.

Now you can go ahead with the next operation. Set the date on the outer scale of RA dial against the local time (as calculated from the IST) marked on the semicircular scale. Now the inner scale of RA dial will show the Right Ascensions of stars in the sky in their correct orientation for that particular time and date. To locate any particular star (or planet) you have simply to find out its RA and Declination

(*Continued on page 716*)

### Table 4. Mean coordinates of constellations

| *Constellation* | *RA* | *Declination* |
|---|---|---|
| Andromeda | 1h | 40°N |
| Aquarius | 23h | 15°S |
| Aquila | 20h | 5°N |
| Aries | 3h | 20°N |
| Auriga | 6h | 40°N |
| Bootes | 15h | 30°N |
| Cancer | 9h | 20°N |
| Canis Major | 7h | 20°N |
| Capricornus | 21h | 20°S |
| Carina | 9h | 60°S |
| Cassiopeia | 1h | 60°N |
| Centaurus | 13h | 50°S |
| Cepheus | 22h | 70°N |
| Coma Berenices | 13h | 20°N |
| Corona Borealis | 16h | 30°N |
| Corvus | 12h | 20°S |
| Crux | 12h | 60°S |
| Cygnus | 21h | 40°N |
| Eridanus | 3h | 20°S |
| Gemini | 7h | 20°N |
| Grus | 22h | 45°S |
| Hercules | 17h | 30°N |
| Leo | 11h | 15°N |
| Libra | 15h | 15°S |
| Lyra | 19h | 40°N |
| Ophiuchus | 17h | 0° |
| Orion | 5h | 5°N |
| Pegasus | 22h | 20°N |
| Perseus | 3h | 45°N |
| Pisces | 1h | 15°N |
| Sagittarius | 19h | 25°S |
| Scorpius | 17h | 40°S |
| Taurus | 4h | 15°N |
| Ursa Major | 11h | 50°N |
| Ursa Minor | 15h | 70°N |
| Virgo | 13h | 0° |

**A. K. BANERJEE**
**S. K. SRIVASTAVA**

**The use of fluorescent X-ray spectrometry in the field of chemical analysis has manifold advantages over the conventional wet-chemical methods. It is a convenient, non-destructive, more accurate, more economic and less time consuming technique**

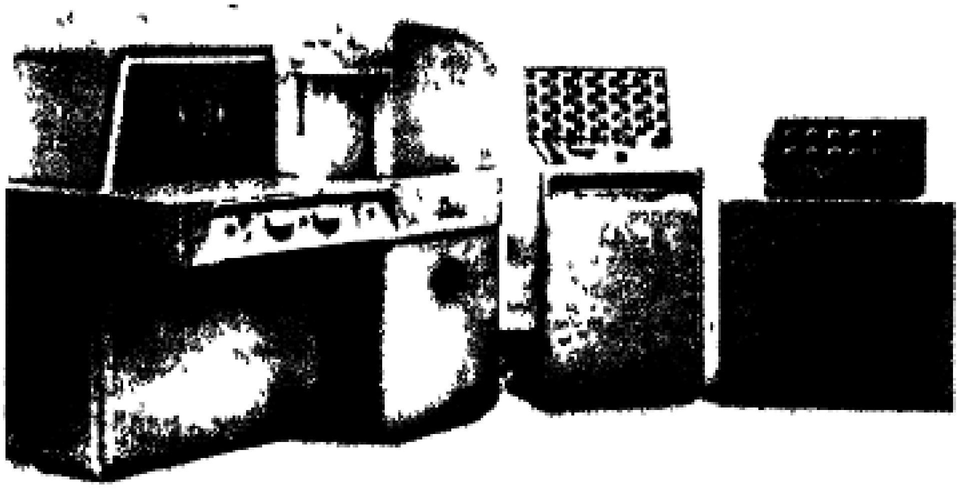
# FLUORESCENT X-RADIATION AS AN ANALYTICAL TOOL

THE idea of utilising fluorescent X-ray for qualitative and quantitative analysis of samples began to take shape since 1923, with the pioneering work of G Von Hevesy and D Coster It was known that the characteristic X-ray spectra of the elements in a sample could be excited by a sufficiently energetic primary X-ray beam, and that these secondary or fluorescent spectra could be used to identify the elements present in a sample But the extremely low intensity of the fluorescent rays restricted its usage as an analytical tool So for about forty years, analysis by X-ray fluorescence spectrometry was known as a potentially powerful but practically useless method

The last three decades have seen great advances in fluorescence technology particularly in its applications of the needs of industry More intense primary X-rays, more sensitive detectors and greatly improved optics have added to versatility of the instrument and made analysis by this method economically viable Especially in metallurgical industry, a fluorescent X-ray spectrometer can be operated continuously for thousands of hours The spectrum of analysis ranges from atomic number 12 (magnesium) to as high as atomic number 96 (curium) The samples are normally not destroyed or affected by the analysis and very small specimens can be handled successfully

## The phenomenon of X-ray fluorescence

Certain salts of metals when subjected to X-radiation are "activated" and emit light This is nothing but the characteristic radiation produced due to absorption of X-ray energy In these salts, the characteristic radiation happens to have a wavelength so long that it falls within the visible range In the case of barium platinocyanide or calcium tungstate, the light thus produced is green Zinc silicate and calcium sulphide fluoresce blue (In true fluorescence the absorption and emission take place in a short but measurable time, of the order of microseconds) Fluorescence is not, however, confined to wavelengths of visible light It can be observed in the form of fluorescent X-ray as well



The mechanism of emission of fluorescent radiation can be explained on the basis of Bohr concept of atomic structure When a high energy X-ray photon is absorbed by an atom, an electron may be ejected from one of its inner shells, say from the K-shell The quantum of energy of exciting radiation must exceed the energy required to dislodge K-electron The vacant space of the electron is then immediately filled by an electron jumping from the outer shell In this transition a photon is emitted The characteristic K radiation of the element is emitted when an L or M electron replaces the one dislodged (Fig 1) As this

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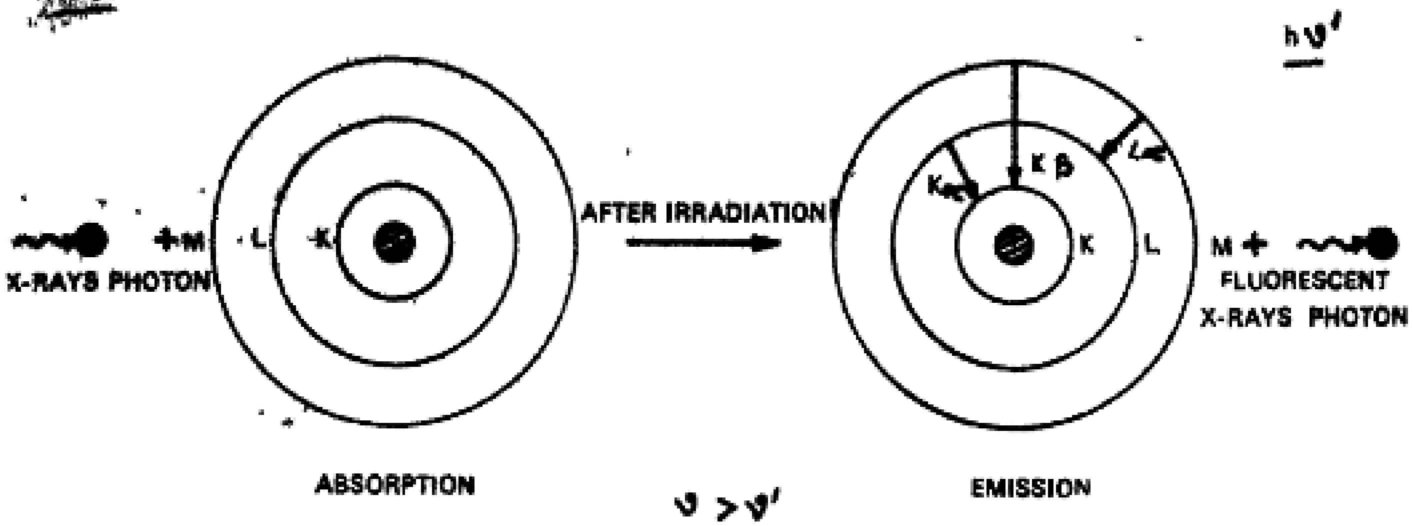

Fig 1 Electronic transitions associated with the fluorescence phenomenon

radiation is always of longer wavelength than the exciting radiation, it is called fluorescent radiation.

So we see that X-ray fluorescence is due to electronic transitions from outer shells to inner shells causedby the absorption of high energy X-ray photon. Since each transition is discrete and characteristic, the energy or wavelength of the radiation may be used as unique means of characterising the element in the material. The fluorescent X-rays generated from a sample provide an unequivocal identification of the elements present in it. Their intensity measurement gives an index of the amount of each element present.

**Matrix effect**

Quantitative analysis of a sample is made possible by the proportionality of fluorescent intensities to concentration. However, the recorded intensity of the spectra emitted from a sample depends on the instrumental design and operating conditions as well as on sample composition. The analysis of a multi-component system, such as an alloy, is complicated by the fact that the fluorescent intensity of any one element depends not only on its own concentration but also on the concentration of the other elements present. This is termed as 'Matrix effect'. It occurs due to variations in absorption by the sample of the incident X-rays beam and fluorescent X-ray generated in the sample. The variations in absorption are governed by the composition of the sample.

Copper and iron in the same specimen provide a classic example of matrix effect. This is illustrated in

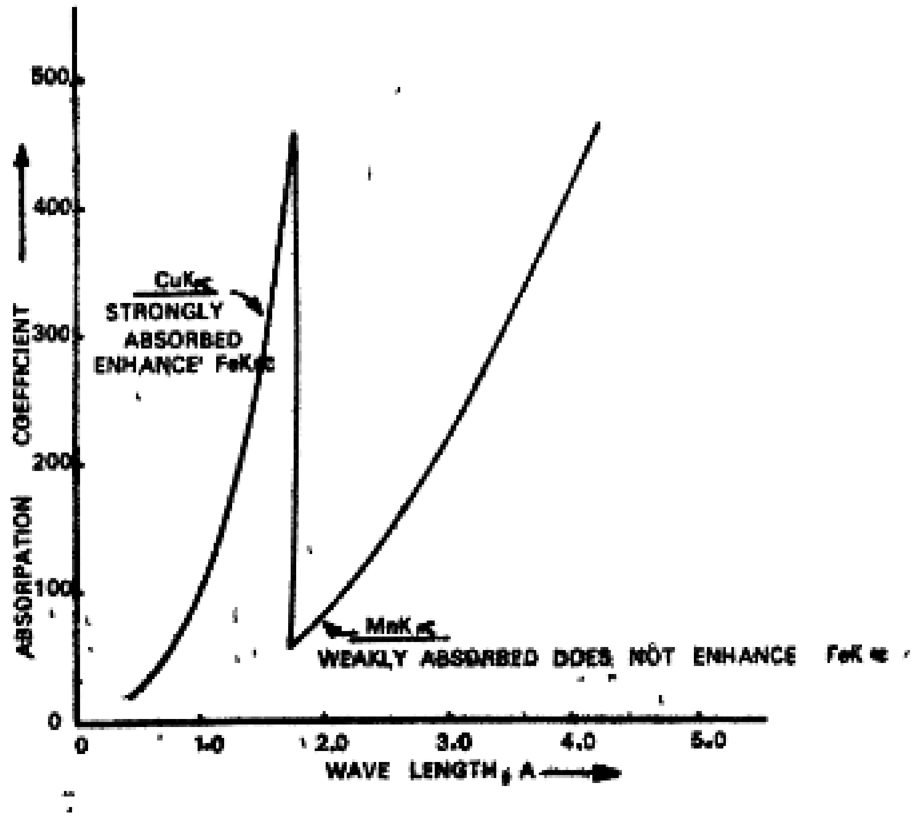

Fig 2. Absorption coefficient of Fe and its interaction properties with copper and manganese

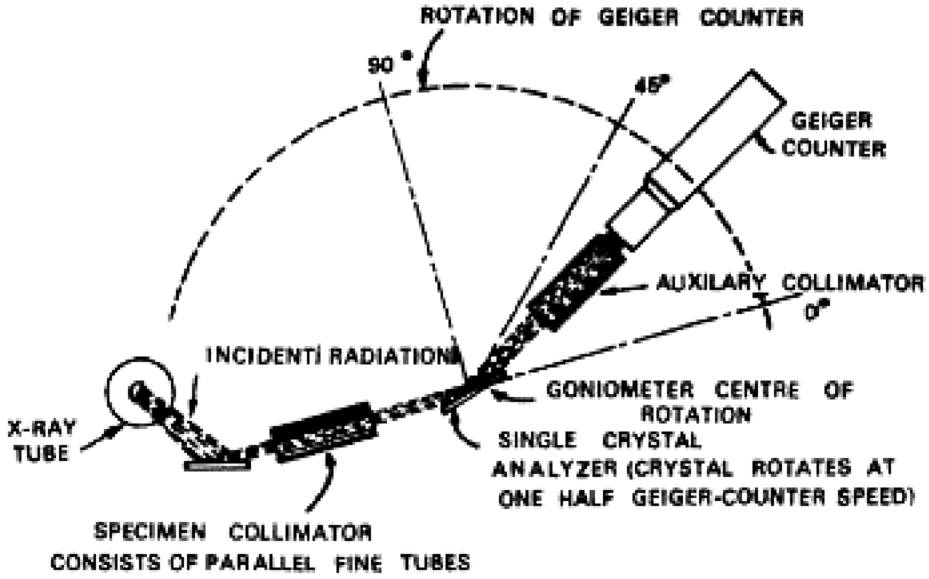
ROTATION OF GEIGER COUNTER
90°
45°
GEIGER COUNTER
AUXILARY COLLIMATOR
0°
INCIDENTI RADIATION
GONIOMETER CENTRE OF ROTATION
X-RAY TUBE
SINGLE CRYSTAL ANALYZER (CRYSTAL ROTATES AT ONE HALF GEIGER-COUNTER SPEED)
SPECIMEN
COLLIMATOR CONSISTS OF PARALLEL FINE TUBES

**Fig. 3.** Schematic diagram of X-ray fluorescence spectrometer

Fig. 2. Here, the absorption coefficient (which is a measure of absorption) of iron has been plotted against wavelength. The absorption edge (i.e, the wavelength at which absorption is maximum) of Fe is at 1 739 Å and the Kα emission line of Cu is at 1.537 Å. The 1.537 Å copper radiation, occurring on the short wavelength side of the Fe absorption edge, is strongly absorbed by Fe. This absorbed radiation excites and further enhances the characteristic radiation of Fe over that generated by the primary exciting beam. If Mn rather than Cu coexists with Fe, the interaction effects are much less pronounced. The Mn Kα line occurs at 2.098 Å, on the long wavelength side of the Fe absorption edge, and therefore is not strongly absorbed. Similarly, the Fe Kα line at 1.932 Å, on the long wavelength side of the Mn absorption edge at 1.892 Å, does not enhance Mn.

## Correction for matrix effect

A number of methods are now available to compensate for this inter-element effect. The degree of suitability of a method is judged according to the problem to be dealt with. The common methods are: dilution, external standards and internal standards. The outlines of the different procedures are given below.

In dilution technique, the substance to be analysed is diluted in high ratio with a substance which is relatively transparent to X-ray such as carbon, lithium carbonate, borate glass and oxides of the low atomic number metals. The degree of dilution required to minimize or eliminate interaction can be calculated by the use of absorption constants of the specific material, or it can be determined by experiment. The external standards method is based on the use of a number of reference standards which closely simulate the various compositions to be analyzed. A set of calibration curves is often helpful for this purpose. In case of internal standards, a fixed ratio of an added element in a sample serves to compensate for the interaction. To overcome the matrix effect, thin film technique has also been used by many workers.

## Fluorescence unit

A diagram of a basic fluorescence analysis unit is shown in Fig. 3. The target in the X-ray tube is usually tungsten because of the short wavelength and correspondingly high energy of its X-ray spectrum (minimum voltage=69.30 kV). The X-ray beam produces the characteristic X-ray spectra of the elements present in sample. The fluorescent X-ray are passed through a collimator, and the nearly parallel beam of polychromatic radiation strikes an analysing crystal. The crystal acts as a three-dimensional diffraction grating and, by proper positioning, reflects each of the individual radiations at a specific angle in accordance with the well-known Bragg equation, $2.d \ \sin\theta = n\lambda$, where d is the interplanar spacing of the analysing crystal, $\theta$ the grating angle of incidence and n the order of reflection. Longer wavelengths are dispersed to higher angles while the shorter wavelengths are dispersed to smaller angles. The intensity of fluorescent radiation is measured with a Geiger counter or scintillation counter, the position of which can be accurately read on a goniometric scale. The output of the Geiger counter is fed into a strip-chart recorder for normal qualitative or quantitative analysis, or into

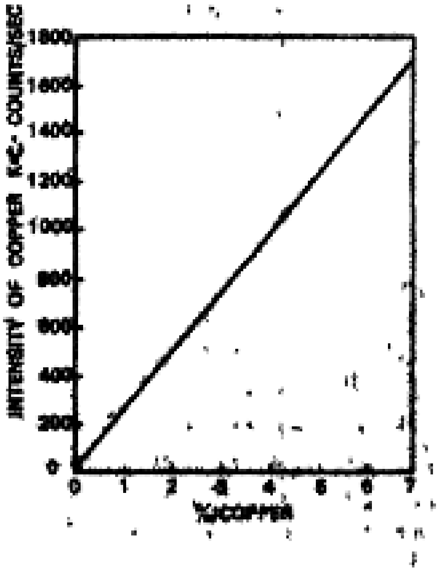

**Fig. 4.** Calibration curve for the determination of copper in an aluminium alloy

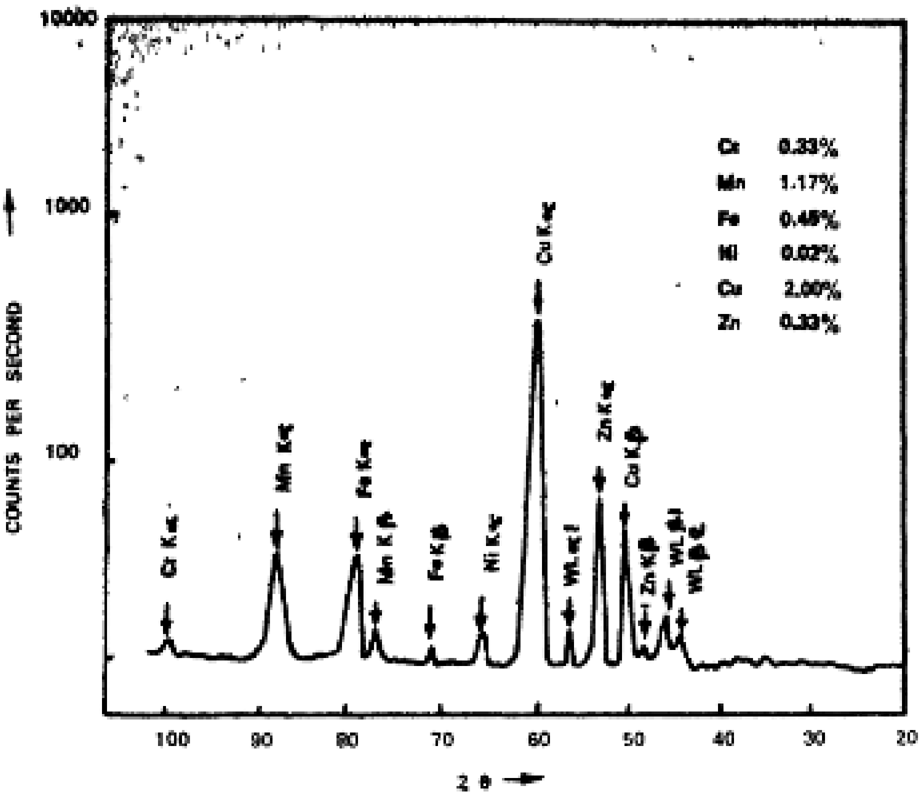

Fig. 5. Fluorescent spectrum of an aluminium alloy

a count register when extreme precision is required. Simultaneous analysis of 24 elements can be made by means of multichannel recording system. Here the diffracting crystal moves automatically from 0° to 90° while the detecting system moves simultaneously from 0 to 180° to detect the entire range of elemental analysis.

### Technique

The sample for the X-ray fluorescence can be liquid, powder or solid. Powdered samples are made into pellets with boric acid by compression. The pellet is then placed in the sample holder. Metals and alloys are used as such.

For quantitative analysis, the spectrogoniometer is set at a specific angle corresponding to the element to be analysed. For each element the angle is determined from the wavelength of fluorescent X-radiation and d-value of the diffracting crystal. The intensity of the radiation is accurately measured with a Geiger counter. Standard samples of known chemical composition, similar to those to be analysed, are prepared to obtain the calibration curves. A typical fluorescence analysis chart of an aluminium alloy is shown in Fig.4 and a calibration curve for the determination of copper in this alloy is shown in Fig. 5.

### Sensitivity

The sensitivity of X-ray fluorescence applied to various substances is highly dependent upon the matrix and nature of the element measured therein. Generally, the sensitivity varies directly with atomic number of the element and inversely with the atomic number of the matrix in which it is measured. For example, 10 parts per million of iron can readily be detected in celluose or hydrocarbons, whereas in a matrix of higher atomic number, such as titanium, which is more absorbing, iron sensitivity is lowered by about two orders of magnitode. The sensitivity depends also on the atomic number of the element to be detected. The fluorescent yield decreases with atomic number. To illustrate, the fluorescent yield of iron (26) is about three times that of calcium (20). This, with the property of being more easily absorbed, lowers the absolute sensitivity for calcium to a level considerably below that for iron in most substances.

### Applications

The range of application of fluorescent X-ray is very wide. It has been successfully applied in many spheres. Metal industries have been in the forefront of the development and applications of X-ray fluorescence. Analysis of all metal alloys, both ferrous and nonferrous, can be done for major or minor concentrations of elements with precisions as good as or better than those obtained by conventional chemical methods, but at a fraction of cost in time and effort. X-ray fluorescence has been particularly useful in the analysis of rare earth minerals. Microgram quantities of elements like zinc, vanadium, iron, nickel, etc.. can be detected by this technique

The study of compositions of dynamic systems by fluorescence technique has been most facinating. The evaluation of the different species change with time, such as the rate of dissolution of solids in solids or solids in liquids (for example, $CuSO_4$ in water), rate of mixing of liquids, rate of precipitation from solution, diffusion of metals during phase transformation, rate of corrosion of surfaces, etc., can easily be made by this technique.

Fluorescent X-ray spectroscopy has several advantages over the wet-chemical analyses. It is more economical in the industrial field, especially in metallurgy. It meets the three

(*Continued on page 731*)

## Solution to brain-teasers

1. See Fig. 2.
2. The fact that Ramu did not have to peel any orange indicates that the number of oranges in the basket was odd, for otherwise this condition cannot be satisfied. The solution is easily obtained by working backwards. Before selling to the third customer Ramu had seven oranges left; before selling to the second customer he had fifteen left; and before selling to the first he had thirtyone left. So the number of oranges originally in the basket was 31.

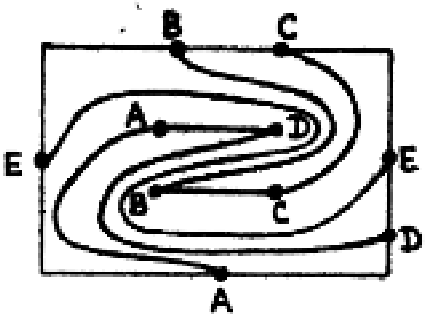

Fig. 2

3. The only four numbers in the range 1930 to 1970 which when divided by 2 give upside-down numbers are 1932, 1936, 1938, and 1962; the resulting numbers being 996, 896, 696 and 186. Of these only the number 186 when divided by 6 gives a prime number 31 whose reversal is 13. So the required house number is 1962.
4. Call $x$ and $y$ the number of stamps received by Rohit and Amit respectively. The conditions of the problem establish the following equations :

$$x+\tfrac{1}{3}x = \sqrt{xy} \quad .. \quad (1)$$

$$x+y = 100 \quad .. \quad (2)$$

Eq. (1) on simplification gives $16x=9y$. Solving this with Eq. (2) gives $x=36$ and $y=64$. So, Rohit and Amit received respectively 36 and 64 stamps from their uncle.

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STARFINDER (*Continued from page 711*)

values from Table 2, and set the two pointers accordingly against the RA and Declination dials. You will see the required star or planet if you now look through the sight. If you are interested only in locating the constellations you may look up in Table 3 the RA and Declination values for the prominent constellations.

You may cut out the RA and Declination dial patterns from the pages of *S.R.* and paste them on any hard board or plywood. That will save you a lot of trouble. But remember, the accuracy of your instrument will depend on your workmanship!

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# SCIENCE SPECTRUM

## The strange case of N-rays

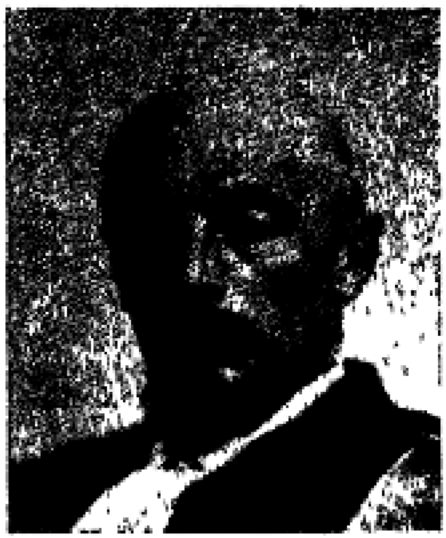
DO you know who discovered N-rays? You can take all the time in the world to find it out, and hundred per cent failure is guaranteed! Not that nobody discovered N-rays, and they rained down from the sky to become a part and parcel of science. In fact, N-rays themselves have not been discovered! One can easily call them "No-rays". Then, what is this hullaballoo about? The case of discovery of N-rays is unique in the history of science. For a time it took the world for a ride, and eventually faded out into oblivion. Such a miserable failure it was that even in the history of science it did not appear as a lesson to future discoverers as it ought to have.

In 1903, a few years after the discovery of X-rays by W. K. Roentgen, a distinguished physicist René Blondlot decided to examine whether X-rays were a wave or a stream of particles as per the demand of the time. Blondlot was not a well known crackpot but a person much revered in his field. He was a Professor of Physics at the University of Nancy, France, and also a member of the French Academy of Sciences. For the examination whether X-rays were a wave or particles the standard experiment was to pass X-rays either between two charged plates or through a spark-gap between two electrodes which could be oriented at any angle. If the X-rays were a stream of particles they would be deflected or attracted by the plates. On the other hand, if the X-rays were waves, the spark between the electrodes would brighten up on a particular orientation. In other words, because of polarisation of X-rays, a component of X-ray waves would increase the brightness of the spark between the electrodes.

When Prof. Blondlot passed X-rays through the spark-gap, the spark indeed brightened up at a particular orientation of the electrodes. In short, it was proved that X-rays are waves. Now comes the quizical part of the experiment. For reasons which are yet unknown, Prof. Blondlot saw the brightened up spark through a quartz prism. To his great surprise he found that the prism had bent the incoming rays, which was contrary to the properties of X-rays. X-rays pass easily through a quartz prism and so there was no question of their bending. So the obvious deduction was that some new kind of rays were passing through the quartz prism. After taking all the precautions that Prof. Blondlot was capable of to remove any sources of error, when the results were found consistent, he declared to the world that he had discovered a new kind of rays. He called them "N-rays", where N stood for Nancy of the University of Nancy. His paper on the discovery promptly appeared in the issue of the France's prestigious journal *Comptes rendus*.

All over the world scientists greeted the discovery. Some began preparations immediately to produce N-rays themselves; others, especially French scientists and Blondlot's colleagues, went on to study N-rays in more details. In that very year of discovery three more papers on N-rays appeared in the aforementioned journal. In the next year about 54 more papers giving new facts and figures on the new rays appeared in the journal. And not only physicists, discovered new things about the rays but also physiologists and psychologists each giving the best possible ways to exploit the new rays in the service of the mankind. It was found that N-rays could easily pass through wood, paper, mica, paper, paraffin, thin sheets of iron, tin, silver and gold. Water and rock salt were, however, found to block the rays. Gas burner, Nernst glower, heated pieces of iron and silver were found to emit intense N-rays and so were adopted as sources in various experiments. Lenses and prisms of aluminium were also made to focus or bend the N-rays for various experiments.

A stir was created when Augustin Charpentier, a colleague of Prof. Blondlot, discovered that N-rays were also produced in nature. Besides the sun it was claimed that human body, especially nerves and muscles, produced N-rays, the result of which was that many medical applications of the rays



**Prof. René Blondlot** (*left*), **the "discoverer" of N-rays, and Prof. R. W. Wood** (*right*), **who proved that N-rays do not exist**

were discovered. Another interesting development, which often accompanies any great discovery, was the claim made by many other scientists for the priority of the discovery. One scientist went on to claim that he had discovered N-rays seven years before Prof. Blondlot! Besides, in 1904, the French Academy of Sciences bestowed on Prof. Blondlot the prestigious *Prix Leconte* Award of 50,000 francs. It is believed that the first draft of the citation of the Award read that Prof. Blondlot had been given the Award for the discovery of N-rays. At the eleventh hour, however, the Award was given to him for his total contributions to physical sciences. Perhaps, the inability of scientists outside France to generate N-rays had by that time reached the ears of the Academy members.

One of the eminent physicists who had tried unsuccessfully to produce N-rays in his laboratory was R.W. Wood, a Professor of Physics at the John Hopkins University, U.S.A. An expert on optics and spectroscopy, he was also renowned as a notorious prankster and perpetuator of hoaxes. Apart from his dealings with the supernatural things, he once also created a fake photo of a U.F.O. When many eminent scientists in England, the U.S.A. and elsewhere, namely, Lord Kelvin, William Crookes, were not able to reproduce Prof. Blondlot's results they urged Prof. Wood to visit the former's laboratory at Nancy and see the first-hand demonstration of N-rays. Prof. Wood readily agreed and after spending three hours in Prof. Blondlot's laboratory reported his findings in the September 29, 1904 issue of *Nature*. He claimed that not a single demonstration had convinced him of the existence of N-rays. His research paper dealt a death blow to the further researches in N-rays at least outside France. Soon after research papers on the subject ceased to appear in the journal *Comptes rendus*.

In the first demonstration Prof. Wood was shown how N-rays, which were focussed on to a spark gap, were affected by a human hand. It was claimed that as soon as the hand was brought in the path of N-rays, the brightness of the spark diminished. However, Prof. Wood could not detect any change in the brightness of the spark. When he told Prof. Blondlot so, the latter remarked that his eyes were not sensitive enough to detect the change. Prof. Wood, therefore suggested another test. He told Prof. Blondlot and his colleagues that he would himself put his hand in the path of N-rays and they should judge whether his hand was in the path of N-rays or not from the change in brightness of the spark. According to Prof. Wood, no one would give even a single correct answer.

But judging brightness of light is an unreliable method and so another experiment was demonstrated which included a photographic plate. Here, again, Prof. Wood claimed that there were too many errors. In fact, the brightness of the spark itself fluctuated all by itself by as much as 25 per cent what to speak of other errors, he claimed. In another experiment, which was conducted in a dark room, an aluminium prism was shown to be splitting N-rays into many N-rays of different wavelengths, just as a glass prism splits ordinary light into a band of colours. While this experiment was in progress, Prof. Wood stealthily removed the prism, but to his surprise it had no affect on the outcome of the experiment! In another experiment he again managed to replace unobserved a steel file, a source of N-rays, by a similar piece of wood and found that it, too, had no bearing on the results the experimenters intended to show.

Although N-rays gained disrepute outside France since the publication of Prof. Wood's paper in *Nature*, it still held the ground in France, especially in the vicinity of Nancy. Obviously, the pride of "French" physics was at stake. Prof. Blondlot therefore further modified the apparatus for generation of N-rays, but this time he also issued instructions for the optimum conditions required to observe them. For instance, he claimed that N-rays can be easily observed in a room in which no body is smoking, there is complete silence and the eyes of the observer are not strained. He even claimed that not necessarily everybody could observe N-rays! His supporters also went to the extent of claiming that some races of human beings could only see N-rays (of which French were presumably the privileged). So until Prof. Blondlot's death in 1930 the conception of N-rays did not die. It remained a topic of gossip and laughter in a limited scientfic circle for some time before it suddenly vanished into the thin air just as, earlier, N-rays had come out of it.

The question that faces the historians of science is: How did such a discovery pass the muster so easily before it was too late? It has indeed proved to be an interesting case study of the psychosociology of science. According to Irving M. Klotz of the Northwestern University, U.S.A. (*Scientific American*, May 1980) one has to study the environment in which the discovery was made to give an answer. Those were the beginnings of the 20th century, when X-rays had been discovered and their properties being studied. Many other kinds of radiations, namely, alpha, beta and gamma radiations, had subsequently been discovered and studied. The discovery of new kinds of rays was then as much anticipated as today the discovery of a new pulsar is. So when Prof. René Blondlot declared the discovery of N-rays, everybody took him for granted. Of course, Prof. Blondlot had sincere intentions and in no case he wanted to create a hoax and become famous. N-rays was basically a genuine mistake on his part.

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# *Cis*—platinum

THE use of platinum as an anticancer agent is a well-known story of serendipity, and its application in the form of needles is an established therapeutic practice. Compounds of platinum have found wide use in chemical industries as a catalyst and in photography. Platinous chloride was earlier used for the treatment of syphilis. Inhalation of the dust of soluble salts of platinum is toxic to human beings and the maximum allowable concentration is limited to 0.002 mg/cu.m. Certain compounds of platinum cause direct damage to tubular tissues of the kidney. *Cis*-platinum is a new discovery in the field of medical research during the past fifteen years.

In 1965, while investigating the effects of an electrical field on bacterial growth, an interesting observation was made by Rosenberg and coworkers (*Nature*, **295**, p. 698) that replication of the microorganism *Escherichia coli* was inhibited markedly if the current was passed between platinum electrodes. They later found that the growth inhibition was not caused by the electrical current, but by platinum compounds formed in the medium. This led to further systematic investigations of these compounds of platinum, and one of them was identified as *cis*-dichloro diamino platinum II (DDP). It is now commonly known as *cis*-platinum.

Since 1972, *cis*-platinum has been available as a research drug from the National Cancer Institute, Bethesda, U.S.A. and it is now readily obtainable from Britain on a commercial scale under the name neoplatin for therapeutic use.

DDP has the formula $(N_3H)_2PtCl_2$ (mol. wt-300.1) with the structure shown in Fig. 1. The active form is the divalent platinum derivative and it is one of the most active antitumour agents in animal systems.

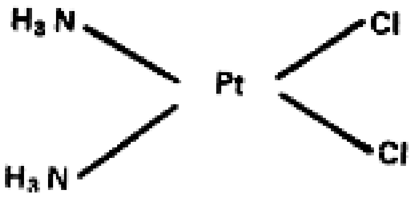

Fig. 1

*In vitro* studies have shown that DDP is inhibitory to the biosynthesis of deoxyribonucleic acid (DNA) in a selective and persistent manner, while the synthesis of ribonucleic acid (RNA) as well as proteins is relatively spared. There is some parallelism between the mode of action of nitrogen mustards and of DDP as bifunctional alkylating agent. The activity observed with DDP against animal tumours has been attributed to its binding to cellular DNA; it has been proposed that two types of bidentate bonds are formed —bidentate to one strand and bidentate between strands. It has also been observed that DDP binds to all the bases except thymine. Many variations of DDP structure have been studied, but no compound has yet proved to be superior to *cis*-platinum.

Oral administration of DDP is the more common practice and the daily dose is 15 mg to 20 mg per metre square body surface for five days. Other schedules for treatment include daily injections for five days, a five day continuous infusion or 24 and 48 hour infusions. DDP is available in 10 mg amber phials, and it has to be dissolved in 10 ml. sterile water before administration. Unopened phials of dry powder should be stored in a refrigerator around 4°C for not more than two years. The reconstituted solution is stable at room temperature for twenty-hours and it should not be kept in the refrigerator lest the drug should be precipitated.

DDP has toxic effects, the major ones being nausea and vomiting, renal damage, hearing loss, anaphylactic reactions, leucopenia and thrombocytopenia (reduction of leucocytes and thrombocytes). Since the toxic effects are cumulative, careful monitoring of peripheral blood counts and of renal and auditory functions are essential to contain the undesirable effects during treatment.

*Cis*-platinum is one of a unique group of antitumour agents to be used clinically in recent years and has remarkable effect against several solid tumours including those of testis, ovary, bladder and neck. It is constantly under further study and may prove a very valuable antineoplastic drug of choice.

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# A new method of cleaning mercury

THE classical method of cleaning mercury is by spraying it through a column of nitric acid. The method, as described in the *Handbook of Chemistry and Physics* (1957), is as follows: Allow the mercury to fall in a fine spray into a column of dilute nitric acid (25 parts of acid to 75 parts of distilled water). After being passed through the acid one or more times, it should be passed through distilled water and dried. Most of the water may be removed when the mercury is heated in a porcelain dish to about 110°C. To produce the spray, the stem of a glass funnel may be drawn down so as to leave only a small opening for the escape of mercury.

A 90 cm-120 cm length of 2.5 cm dia glass tube closed at one end and supported in a vertical position may be used to contain the acid solution. If a small glass tube is fused into the lower closed end of the large tube, and bent so as to stand up for a distance a little greater than 1/13.6 times the column of acid solution in the large tube, a U-tube is formed in which a short column of mercury supports the long column of acid solution.

The end of the small tube should be bent over at the top so as to facilitate delivery of mercury and a short piece of clean rubber tubing with a pinch-cock put on at the start; as soon as enough mercury has collected in the bottom of the tube, the pinch-cock is opened. Mercury will rise nearly to the top of the small tube, and as the quantity increases it will be delivered from the small tube as fast as it falls in the spray. The reversed end of the small tube should be short to avoid formation of a siphon which would completely empty the apparatus.

An efficient procedure, especially if the mercury is greasy, consists of spraying mercury by means of the above apparatus, first, through a dilute solution (10%) of potassium hydroxide, then through dilute nitric acid (10%-15%) and finally through distillod water.

The above method is quite inconvenient, particularly if large quantities of mercury are involved, and leaves some of the mercury in an ionized state.

## A new method

A simple method for cleaning the surface of mercury had been suggested by Howard L. Davidson and Robert Rinker of the University of Colorado and National Bureau of Standards, Colorado, in the *Reviews of Scientific Instruments* (1974). According to them, one has to pour about 4 ml. of laboratory grade collodion over the surface of mercury. The film should be continuous and be in contact with the walls of the container on all sides. If left to dry slowly for a few hours, the film shrinks, and in general, pulls itself away from the walls at all but one point. It may then be carefully removed from the mercury and peeled off from the wall. With a little practice, it is quite easy to recover the film intact and leave no fragments behind.

If an attempt is made to hasten drying by blowing a stream of gas over the surface, the film may wrinkle badly and trap mercury droplets in its folds. Caution should also be observed if the mercury container is permeable to the ether solvent used to carry the collodion. The shrinking film is capable of pulling off pieces of the container if it has penetrated the surface.

Repeated treatments will work even for particularly dirty mercury. It is helpful to gently stir mercury between treatments to release materials trapped on the walls of the container.

Collodion is commonly available in three forms : laboratory grade collodion, collodion U.S.P., and flexible collodion. The first two are apparently indistinguishable and form rather stiff wrinkled films which are easily torn. Flexible collodion forms extremely tough films which ordinarily do not wrinkle. This form of collodion is not recommended for the above method.

The author's experience in trying the method is that a collodion film of about one to two mm thickness dries in five to ten minutes. This method is rapid too. But, one should be aware of the fact that collodion costs more than Rs. 100 per 500 ml.

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# Non-toxic fungicides

A heavy loss of foodgrains in fields and storage occurs due to a number of pathogenic fungi. Lack of proper storage and the presence of a warm, moist climate facilitate fungal growth and infection. Hence, use of fungicides cannot be avoided in these countries. Conventional fungicides are toxic to animals, possess residual effect and their cumulative effect on health is hazardous. They may prevent food spoilage by fungi but make it unfit for human use. It was therefore necessary to search for non-toxic agents to control food destroying moulds.

Some such compounds have recently been isolated from common indigenous plants. They can be prepared easily even by illiterate farmers. The cost of production is almost nil. On boiling with water, mango bark or its tender leaves, and bulbaceous roots of a common herb, *Ruellia tuberosa*, give yellow and brown solids, respectively. They are collected by passing the aqueous extract through bandage cloth. After drying in shade, they are stored in glass containers. The yellow compound from mango leaves and bark, is mangiferin (xanthone-C-glucoside) and the brown one from roots of *R. tuberosa*, a mixture of benzophenones and benzoquinones.

Mangiferin, benzophenones and benzoquinones have been successfully used in controlling disease of safflower (*Phytopathology*, 67, 548, 1977; *Experientia*, 34, 229, 1978), ear rot of maize (*Experientia*, 35, 83, 1979) and fruit rot of mango.

In laboratory evaluations, they have shown strong antifungal activity against a wide range of pathogenic fungi such as *Fusarium solani*, *F. equiseti*, *F. subglutinans*, *Aspergillus niger*. Thus they have the potentiality of broad-based fungicides.

They may be used as seed dressing fungicides. By soaking fruits and foodgrains in the aqueous solution of mangiferin and benzophenone, the fungus inside fruits and foodgrains are destroyed. They may also be used as foliar fungicide. Benzophenone, sprayed on leaves, was found to be translocated to roots (*Experientia*, 14, 229, 1978).

In nature, it has been observed that benzoquinones come out with the root exudate of *R. tuberosa* and drastically reduce the population of fungus, Fusarium, the causal organism of serious root diseases of a number of crops in the surrounding soil (*Experientia*, 14, 1057, 1978).

Properly synthesized and purified mangiferin (*Phytochemistry*, 10, 2425, 1971), benzophenone (*Abstr. 30th Int. Pharm. Cong.* Warsaw, 122, 1976) and benzoquinones (*Experientia*, 34, 229, 1978), give better results and are required at low concentrations to give effective resistance.

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# Heterogenous RNA and its role in eukaryotes

AMONG the four non-genetic RNAs (ribonucleic acids) of eukaryotes, heterogenous Hn RNA seems a most cogitable phenomenon. It shares several properties with mRNA and GC (guanine-cytosine) content similar to that of the genome DNA. Unlike mRNA, however, at least a large fraction of Hn RNA appears never to leave the nucleus. The participation of this fraction in cytoplasmic protein synthesis is considered unlikely. These Hn RNAs are degraded for the most part within the nucleus at a relatively rapid rate. Only about 20 per cent of the Hn RNA, in terms of total nucleotide, is not degraded and has been postulated to be converted into mRNA.

The Hn RNA is found exclusively in eukaryotes. The origin of mRNA in eukaryotes still remains somewhat a puzzle. When mammalian cells are very briefly exposed to $^{32}$P-orthophosphate or isotopically labelled nucleoside precursors, the dominant species to be labelled is not the mRNA of the cytoplasmic polysomes but a polydisperse nuclear RNA fraction. This non-nucleolar nuclear fraction is made up of RNAs whose sedimentation coefficients range widely from 20S-100S (i.e., roughly $1-15 \times 10^6$ d), hence its name heterogenous nuclear RNA (HnRNA or HetRNA).

The decay of Hn RNA within the nucleus is notably rapid (half-life 20 min.-60 min), but a proportion (a quarter to a third) has poly A tracts about 200 nucleotides long, at their 3′-end. A mRNA precursor role of Hn RNA was postulated on this basis. On the other hand, experiments designed to follow the metabolic fate of Hn RNA molecules led to the conclusion that if there were such a relationship it was complex. Most of the radioactive label in Hn RNA could not be traced in the cytoplasm.

Most of the nuclear DNA of eukaryotes is probably non-informational since the DNA content, for example, of mouse cells is sufficient to code for at least one thousand times the number of proteins so far found in mice. Secondly, an analysis of nucleotide sequences based on the renaturation kinetics of DNA denatured after sharing indicates some sequences to occur once in the genome and some many times.

The intermediate repetitive sequences contain the genes for rRNA, tRNA, 5SRNA and histone mRNA. Histone genes are somewhat unusual in that they are reiterated. Most mRNAs come from DNA sequences that are represented once per haploid genome that means from unique or non-repetitious sequences.

Whilst most mRNA would appear to have arisen as the result of transcription of unique DNA sequence, the same is not true for its putative nuclear precursor, HnRNA. Covalently attached to one another in HnRNA molecules are sequences which are transcripts of both unique and intermediate repetitive sequences. The interspersion and length of these sequences in HnRNA reflect to some extent the length and interspersion of the corresponding sequences in the nuclear DNA.

It has also been found that about 200 adenine residues (Poly A) are attached to the 3'-OH end of several eukaryotic mRNAs. Similar sequences are also attached to the 3'-OH end of such HnRNA. HeLa HnRNA fragment of 3000 nucleotides containing the 3' terminal poly A tract hybridize to HeLa DNA at the same rate as mRNA. The remaining 5'-portion of HnRNA molecules however contain; (a) intermediate respective and unique sequences interspersed with one another, (b) two or three short tracts about 30 uridylate nucleotides long each, (c) double stranded regions, and (d) possibly oligo A tracts of 30 units.

Conversion of HnRNA to mRNA involves attachment of a sequence of polyadenylic acid (Poly A) to the both types of RNA. A sequence of 200 nucleotides is added to the HnRNA after transcription is completed and is attached to the 3'-end of RNA molecule. Once the HnRNA molecule is transcribed from DNA, the Poly A sequence is added in a stepwise fashion, by the action of Poly A synthetase. Simultaneous with or after polyadenylation and starting from the 5'-end, a selective degradation of the HnRNA molecules takes place by the action of nucleases. The final product is Poly A(+) mRNA which will finally reach the cytoplasm. Although the real significance of Poly A is still unknown, several possible functions have been hypothesized. The post-transcriptional attachment of Poly A may be a special step in the processing of mRNA and may be related to its transport to the cytoplasm. The presence of Poly A confers to the mRNA special physicochemical properties by which it can be readily retained by nitrocellulose filters or by columns having polyuridine or polydeoxithimidine sequences. This has made possible the rapid separation of mRNAs from the nucleus or the cytoplasm free of other contaminant RNAs and without submitting the cells to the action of actinomycin D.

Another finding has been that mRNAs for histone are directly transcribed from the repetitive sequence in the DNA without the need for a giant precursor molecule (HnRNA) or polyadenylation. It has been demonstrated that the histone mRNAs enter the cytoplasm without delay, whereas the Poly A (+) mRNA have a 15 minutes delay before appearing attached to the polyribosomes. This lag period may be attributed to the processing steps that these mRNAs probably undergo before passing into the cytoplasm.

An interesting fact can be noted regarding poly-adenylation. Attachment of Poly A on all mRNAs occurs exclusively in eukaryotes. A striking difference between prokaryotes and eukaryotes is the absence of histone in the former. It has been found that the histone mRNA is not polyadenylated in eukaryotes. There is no HnRNA intermediate as histone mRNA precursor. There is not sufficient information to explain this conflicting fact that the histone protein which has been newly added to the eukaryotes and plays a vital role in the formation of the eukaryotic chromosomes is synthesized in a manner much closer to the bacterial protein synthesis. But all other proteins as far as is known are synthesized with the help of the mRNAs, all polyadenylated and having HnRNA precursor.

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# Transposon-mutagenesis

THE concept of 'mutation' has undergone several changes since the term was first coined for large hereditary changes in nature by De Vries in the late nineteenth century. Later it was broadened to include the origin of hereditary effects that could be traced to unique changes within the genetic material. The gene mutation (or point mutation) came to literature only after DNA (deoxyribonucleic acid) was accepted as genetic material. Thus, as it is known today, mutations involve changes in the nucleotide sequence usually as a replacement example radiation such as x-rays, γ-rays, fast neutrons and ultraviolet rays or by chemical mutagens (such as ethyl methane sulfonate, nitrosoguanidine, diethyl sulphate, sodium azide, etc.).

More recently, however, some dis-

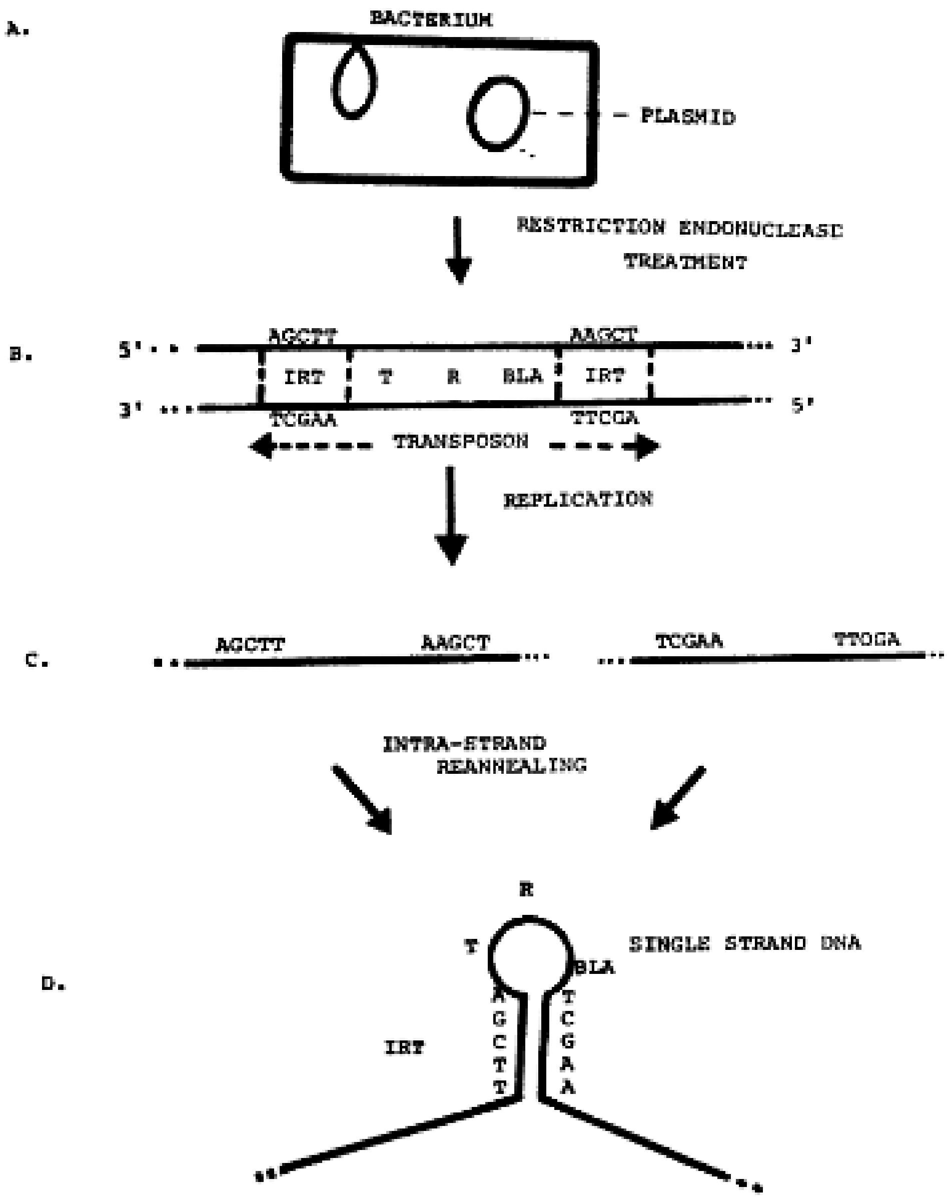

**Fig. 1. (A) Bacterium with a single circular plasmid; (B) Linearised plasmid DNA containing the transposon; IRT—Inverted repeat termini, T-Transposase, R-Repressor of transposase, Bla-Beta lactamase; (C) Strands separated; (D) Intra-strand annealing giving rise to characteristic stem and loop structure**

tinguishable DNA segments have been discovered which insert themselves within many different genes, thereby interrupting the continuity of the gene and turning off its activity (thus causing mutation). Such DNA segments carrying drug resistance genes can move from one DNA molecule to another and hence are called transposons. Although transposons have been studied predominantly in bacteria, they were originally discovered in plants as controlling elements in maize and are now known to exist in animals as well. The process of using transposons as mutagens is called transposon-mutagenesis.

## Nature of transposons

Using electron microscopy J. Kopecko and S. N. Cohen (1975) at Stanford University School of Medicine, California showed that the two ends of the transposon had the unique feature in that the nucleotide sequence at one end (e.g., AGCTT) was complementary in reverse order to a sequence on the same strand at the other end (TCGAA) When a double stranded, plasmid DNA (plasmids are self-replicating, circular DNA molecules of variable size existing independently in the cytoplasm and being transmissible between cells (Fig. 1), carrying the transposon was separated in the laboratory and each of the strands was allowed to reanneal with itself, a characteristic stem and loop structure was formed by the complementary inverted repeats (Fig. 1). To date, more than fifteen different transposons have been identified (Table 1).

**Table 1 Some well-known transposons**

| *Transposons (Plasmid origin)* | *Associated drug resistance* | *Total No of base pairs (terminal repetitions)* |
|---|---|---|
| Tn 1 (RPA) | Ampicillin | 4 800 (140) |
| Tn 2 (RSF 1030) | Ampicillin | 4,800 (140) |
| Tn 3 (RI) | Ampicillin | 4,600 (140) |
| Tn 4 (RI) | Ampicillin<br>Streptomycin<br>Sulphonamide | 20,000 (140) |
| Tn 5 (JR77) | Kanamycin | 5,200 (1460) |
| Tn 6 (JR72) | Kanamycin | 4,100 (not known) |
| Tn 7 | Trimethoprim<br>Streptomycin | Unknown |
| Tn 9 | Chloramphenicol | 2,500 (800) |
| Tn 10 | Tetracycline | 9,300 (1400) |

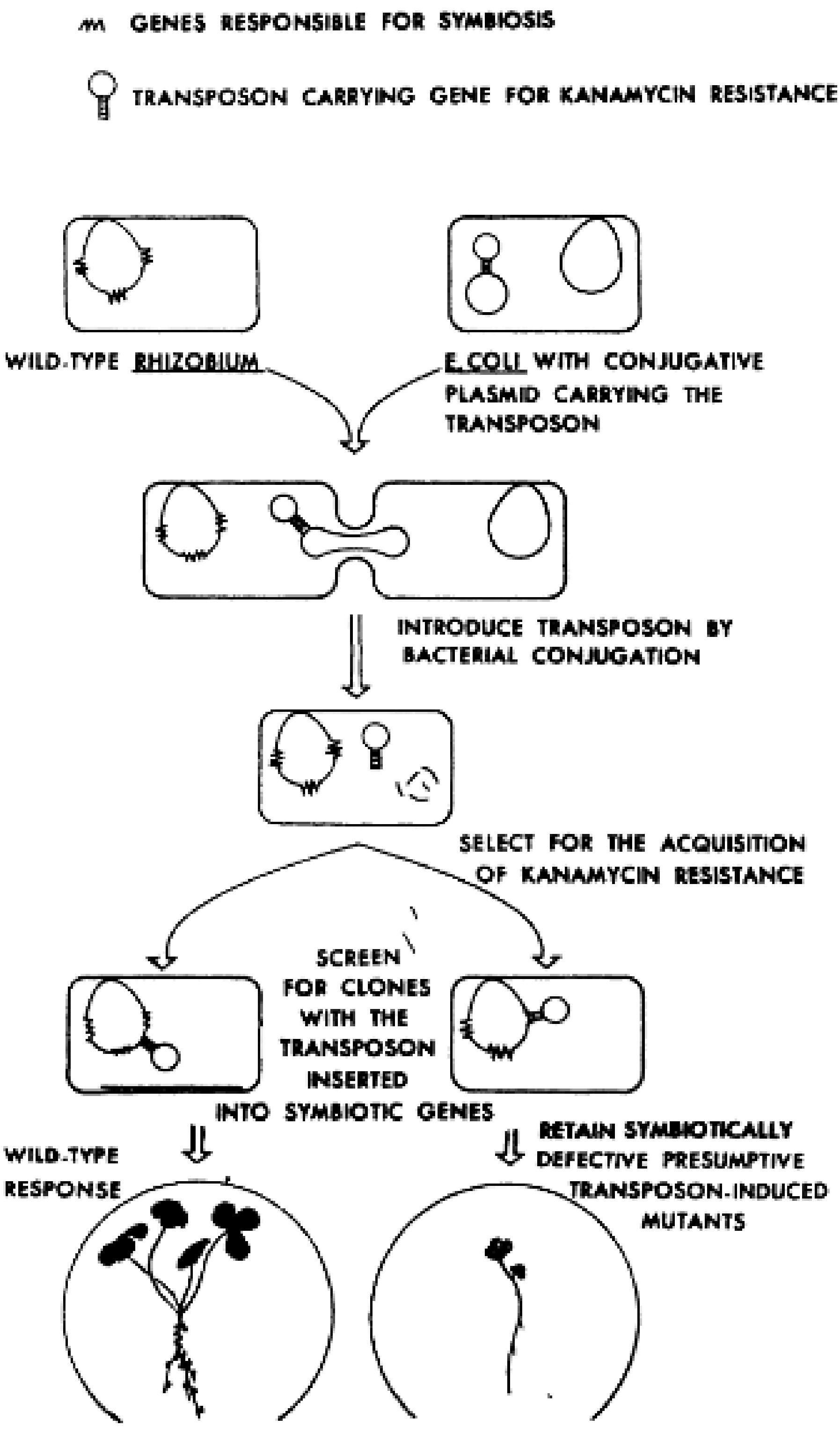
GENES RESPONSIBLE FOR SYMBIOSIS
TRANSPOSON CARRYING GENE FOR KANAMYCIN RESISTANCE
WILD-TYPE RHIZOBIUM
E.COLI WITH CONJUGATIVE PLASMID CARRYING THE TRANSPOSON
INTRODUCE TRANSPOSON BY BACTERIAL CONJUGATION
SELECT FOR THE ACQUISITION OF KANAMYCIN RESISTANCE
SCREEN FOR CLONES WITH THE TRANSPOSON INSERTED INTO SYMBIOTIC GENES
WILD-TYPE RESPONSE
RETAIN SYMBIOTICALLY DEFECTIVE PRESUMPTIVE TRANSPOSON-INDUCED MUTANTS

Fig. 2. Steps in isolation of transposon induced mutants in *Rhizobium*

F.L. Heffron and his associates from the University of Washington and California have recently described the functional components of a transposon (Fig. 1), which comprises of the above mentioned inverted-repeat termini (IRT), a gene for the enzyme beta lactamase (bla) conferring resistance to drugs, a gene coding for transposition (called transposase) and a repressor gene controlling transcription of transposase. Thus, a transposon is a self-regulated discrete sequence of DNA, unable to replicate in an isolated form (in as far that it replicates only when integrated) and thus can be easily handled genetically for inducing mutation.

## Mutagenesis

The first direct evidence of transposon-mutagenesis was published in 1974 by R.W. Hedges and A.E. Jacob of Hammersmith Hospital, London. They found that the transfer of a gene conferring resistance to antibiotics such as penicillin and ampicillin, from one plasmid to another was always accompanied by an increase in the size of the recipient plasmid. The recipient could donate the resistance to still other plasmids which thereupon showed similar increases in size. The inheritance of the antibiotic resistance-traits thus makes it possible to trace the transposon's intermolecular travels.

The ways by which transposons cause mutation are of varied nature. The effects extend beyond their ability to join together unrelated (nonhomologous) DNA segments (sometimes called illegitimate recombination) and to move genes around among such segments. Transposons also promote a variety of structural rearrangements of genetic information including replicon fusions (fusion of two separate and independently replicating DNA molecules), adjacent deletions, adjacent inversions and transpositions. Although the new methods for determining DNA nucleotide sequences have provided an important tool for elucidating the structure of transposons and biochemical mechanisms involved in transposition and chromosome rearrangements, the precise molecular mechanism still remains obscure.

Mutagenesis with transposons is considered efficient mainly because of the low probability of secondary mutations. In other words, the insertion of transposons within recipient DNA is often specific, though some of the well-characterised transposons do induce singular and random mutations. Those are the ones frequently used in the genetic studies.

## Significance

The significance of transposon mutagenesis is mainly three-fold. Firstly, the transposable elements serve as a novel biological switch capable of controlling the expression of nearby genes as a consequence of their insertion into or excision from genomes, thus aiding genome evolution. As a matter of fact the resistance-determinant segments of drug resistant plasmids have evolved as collections of transposons, each carrying a gene(s) that confers resistance to antibiotic(s) Bacteria carrying such resistant genes have a great selective advantage in view of the extensive use of antibiotics in human and veterinary medicine. Secondly, transposons provide a useful tool for the analysis of genetic organisation of *Rhizobium* genes involved in symbiotic nitrogen fixation. The recently developed technique of transposon-induced mutagenesis in our laboratory is outlined in Fig. 2. The drug resistant marker, carried on the transposon, acts as a 'tag' for the genetic and physical location of the affected gene in the *Rhizobium* genome and facilitates easier handling of symbiotic mutants. Furthermore, the antibiotic tag carried on the mutant gene when coupled with recombinant DNA technology, permits molecular cloning of the symbiotic genes inactivated by the transposon. Similarly, insertion of the transposon aids the genetic analysis of resident plasmids in rhizobia by testing for conjugative transfer of, transposon-coded drug resistance. Thirdly, transposons are very useful for the development of genetics of relatively unexplored organisms such as *Agrobacterium tumifaciens* (crown gall bacteria) because of the following reasons :

(1) they provide additional markers on a plasmid that contains no markers suitable to be used in genetic techniques; (2) they can be used as a clean mutagen; (3) transposons can generate deletions in adjacent DNA (starting from a fixed point at the end of terminal repeat) which facilitates mapping; and (4) the position of a transposon can be determined easily by the use of restriction endonucleases (plasmid fragments with transposons will acquire altered molecular weights).

In conclusion, transposon-mutagenesis is a new genetic tool which would elucidate the molecular mechanism of differentiation and development in future.

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# Target cells—a new concept of plant regulation in horticulture

IN 1977, D.J. Osborne of Cambridge Universtiy (presently at Oxford University) first put forward the concept of target cells in the differentiation of plants and indicated how such an approach to developmental processes could be of practical value to horticulturists in their efforts to improve the performance of the plants they are growing.

The term 'Target cell' was originally applied to animals where morphologically differentiated organs were shown to contain cells with specific receptor proteins. These proteins would bind specifically to one of the hormones in blood. Cells can respond to a hormone only if such a specific receptor protein is synthesized. Without this protein, a cell fails to recognise the hormone molecule circulating in the blood and no response is evoked. Such an example is found in the mammary gland of animals. Cells of the mammary glands contain receptor proteins that bind the hormone prolactin, so that in the presence of prolactin the cells are induced to synthesize milk proteins. In plants, the first really clear example of a target cell was demonstrated in 1971 by J.E. Varner and his co-workers in the U.S.A. They showed that in barley grains, the hormone gibberellin produced by the germinating embryo induces the cells of the aleurone layer to produce a group of enzymes including the aleurone-specific alpha-amylase. These enzymes make the starch and other polysaccharides in the endosperm soluble so that they can become available for the growing embryo. The response is very specific gibberellins. No other hormone is effective in causing aleurone cells to synthesize this special protein molecules. Because the effect is hormone specific, aleurone cells can be called target cells for gibberellin (Fig. 1).

## Concept of target cells

It is puzzling to think how a cell develops into an individual which is different from the surrounding neighbour cells. It can be assumed that differentiation of a cell occurs in response to its position along a chemical gradient The chemicals could be externally applied growth regulators or endogenous hormones within the tissue or organ Cells located at particular positions along these gradients will recognise certain signals or chemical instructions and in reply perform a physiological or growth response. During the life time of each cell it will receive a continuously changing selection of such positional information inputs The series of physiological and biochemical responses that it makes to these inputs will determine the future performance of that cell both with respect to new signals from distant cells, and with respect to changing signals coming from the immediate neighbour cells In other words, from the time of embryo formation in the seed each immature cell is already differentiated as a potential, specific target cell Only when we remove cells from their natural environment in the plant and transfer them into tissue cultures can we produce what at first sight appears to be undifferentiated callus tissue As soon as chemical gradients are introduced into callus cultures, the potential for a differential identity between cells is restored and potential specific target cells can once more be initiated

Although many classes of target cells have been recognised in animal tissues, very few examples of specific target cells have yet been identified in plants Osborne and her group of Cambridge University working in Developmental Botany made a careful study of the responses of plant cells to two particular hormones, auxin (indole-3yl-acetic acid) and ethylene Both these hormones are of particular importance in the regulation of cell growth, and there appears to be a feed-back mechanism in the control of growth where each hormone exerts upon the endogenous level of the other It is known that the level of auxin present within a tissue can determine the rate at which that tissue produces ethylene The higher the level of endogenous auxin, the greater is the level of ethylene produced Also it is known that concentration of ethylene to which a plant is exposed can modify the active transport from cell to cell The higher the concentration of ethylene to which the tissue is exposed, the lower becomes the total transport of auxin through the tissue

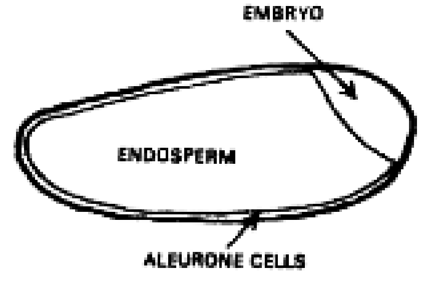

**Fig. 1 Position of gibberellin of target cells in the aleurone layer of a barley grain**

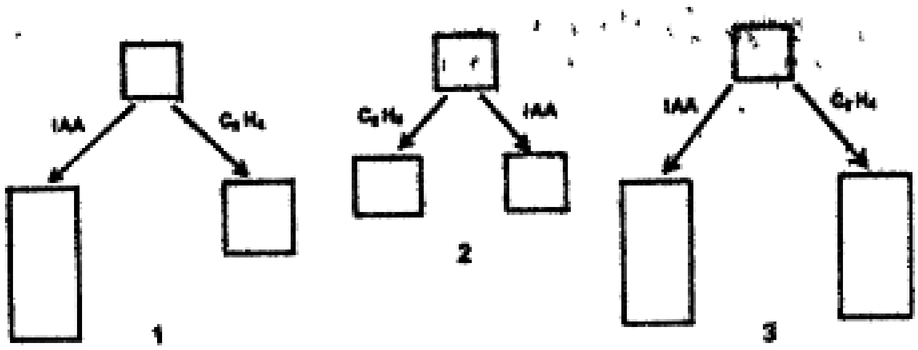

**Fig. 2. Type 1 target cells (1). Type 2 target cells (2); Type 3 target cells (3)**

### Target cells identified in plants

On the basis of the above interrelationships between the two hormones, Osborne was able to provide evidence for hormone-specific target cells for auxin and ethylene in the development and growth of plants Very useful information could be obtained to this end from the types of cell responses exhibited by different organs of plants after they have been treated with auxin or ethylene.

In the gowing shoots of land plants, auxin and ethylene generally exert opposing effects For example, if intact pea plants are sprayed with an IAA (indole-acetic acid) solution, the cortical cells of the immature shoot tissue below the hook will enlarge, elongating 60 % more than the controls during the first nine hours of treatment In contrast, a treatment with ethylene for nine hours does not enhance total cell expansion above that of the untreated plants, but instead causes the expansion that does occur to be oriented in a predominantly lateral direction so that elongation is slightly inhibited and lateral expansion increased The cells of pea shoots are therefore stimulated to enlarge and elongate by auxin but not by ethylene Interestingly cells of abscission zones (zones from where separation of organ from the mother plant occurs) respond in a different way They are stimulated to enlarge and elongate by ethylene but not by auxin In these two cell types, the opposing effects of the two hormones provide a regulatory mechanism for the control of cell size and shape by the balance of auxin and ethylene in the tissue. A different kind of cell growth control occurs in shoots of water plants These plants have cells which enlarge and elongate in response to either added IAA or ethylene. In none of these plants can the elongation response to IAA be attributed to an

IAA-induced stimulation of ethylene production. Since their effects are additive, it seems that IAA and ethylene may have separate mechanisms for stimulating cell elongation. This interpretation of the results is supported by experimental facts. Studies of these cell responses in the different organs show that the growth effects are due to the presence of three distinct classes of target cells. The three classes are :

*Type 1.* Immature cells which are induced to expand in response to auxin, but not to ethylene, e.g., pea stem (Fig. 2-1), *Type 2* Immature cells which are induced to expand by ethylene but not by auxin, e.g., abscission zones (Fig 2-2), and *Type 3* Immature cells which are induced to expand by either auxin or ethylene, e.g., water plants (Fig 2-3)

Although the shoots of most land plants are composed predominantly of Type 1 target cells, this fact can be established only by the kind of growth response that follows upon a treatment with auxin or ethylene. As yet, no biochemical character has been established for this class of cell that permits their recognition before an auxin or ethylene growth response has been evoked. Type 2 target cells are present only in limited numbers in plant shoots and are differentiated at the precise locations of abscission zones at the base of leaves, floral organs and fruits. Cells with Type 2 characteristics are not restricted solely to abscission zones for they can be recognised also in certain ripening fruits; for example, peach, fig and grape. These fruits exhibit two sigmoid phases of expansion growth. In berries of the grape, for example, during the first phase of growth of the fruitlet, the cells of the characteristics of Type 1 are encountered. However, after the quiescent phase and prior to the onset of ripening, expansion growth of cells is enhanced by ethylene and not by auxin, characteristics of Type 2.

## Biochemical basis of identification of target cells

In certain plants there is evidence that it is possible to recognise Type 2 ethylene target cells before they respond to ethylene. It is now known that ethylene responsive target cells are already differentiated for considerable period before they respond to ethylene *in vivo*. For example, in squirting cucumber (*Ecballium elaterium*) flower buds of certain stage of development can be induced to shed if they are exposed to ethylene. However, only those buds which have passed this specific developmental stage can be induced to separate from the pedicel while the very young buds will not do so, no matter how high the level of ethylene they encounter. In buds that are induced to shed, pockets of cells that are induced to enlarge in response to ethylene can be recognised in the general area of cell separation.

Correlations of nuclear sizes and nuclear DNA contents with cell enlargement in response to ethylene show that cells with higher ploidy level (8C) nuclei are not present in buds that cannot be induced to shed with ethylene. It is only when the flower bud has reached a critical stage in development at which pockets of cells with 8C nuclei have been differentiated at the pedicel junction that enlargement and separation can occur with ethylene. This condition has, however, been found to be specific to squirting cucumber. Nonetheless, the fact that in one species the identification of cells with a specific ploidy class can be used for determining the potential for the initiation of flower bud drop when a source of ethylene is provided, affords the horticulturist the basis for a new approach to abscission in other plants.

The existence of Type 3 target cells or those that are caused to expand with either auxin or ethylene, has recently been recognised by Osborne and her research group. These unusual cells make up the majority of those present in shoots of many species of aquatic plants possessing aerial parts. The growth responses observed by the cells in the upper side of the petiole in the tomato plant are very similar to those of Type 3 cells found in aquatic plants. Though both auxin and ethylene induce elongation of this type of cells, the stimulation of cell enlargement by ethylene depends upon the presence of an adequate supply of auxin in the tissue.

These examples of three readily distinguishable types of auxin and ethylene target cells illustrate that during the course of development, plants differentiate a population of highly specific cell classes. Each cell is programmed by the positional information it receives from its neighbours to effect a prescribed positional response and to perform in specific ways to each hormonal input.

## Implications in horticulture

Horticulturists use many kinds of chemical treatments to induce physiological events, and the extent to which they are effective must depend upon the extent to which cells of a plant are receptive and capable of responding. An identification of the various types of target cells that can develop, a knowledge of the exact time when particular types of target cells are differentiated, a means to recognise them cytologically or biochemically when they are differentiated, could be a new and powerful approach to plant growth regulation. But even more important is the need to learn the means of inducing the formation of the required target cells at will. By suitable manipulation of chemical or hormonal gradients between different groups of cells or between organs, it should be possible to cause Type 2 ethylene-responsive target cells to differentiate only when an abscission zone is required. Some success in this respect has been achieved with beans in Osborne's laboratory.

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# Hydrologic cycle

THE chain of events describing the earth's water circulatory system can be represented by a cycle known as 'Hydrologic cycle'.

The cycle involves the total earth system (1) Atmosphere (gaseous envelope above the hydrosphere); (2) Hydrosphere (bodies of water covering the surface of the earth) and (3) Lithosphere (solid rock environment below the hydrosphere).

In hydrologic cycle water evaporates from ocean and land and becomes a part of atmosphere. The evaporated water gets condensed before it is precipitated either on the land or in the sea. The precipitated water may be intercepted or transpired by the plants, may run over the ground surface and into the streams to oceans or may infiltrate into the ground. Much of the intercepted water, run-off and transpired water returns to the atmosphere by a process known as 'Evapo-transpiration'. The infiltrated water percolates downward to form ground water that constitutes "Water table" (the upper surface of ground water or water level in a perennial well). When water table intersects the surface of the earth water comes out in the form of springs and it joins the streams or it forms lakes (Fig 1). Runoff water reaches the ocean and a part of it may be evaporated during its flow to complete the cycle.

Thus hydrologic cycle in nature undergoes various complicated processes such as evaporation, precipitation, interception, transpiration, in

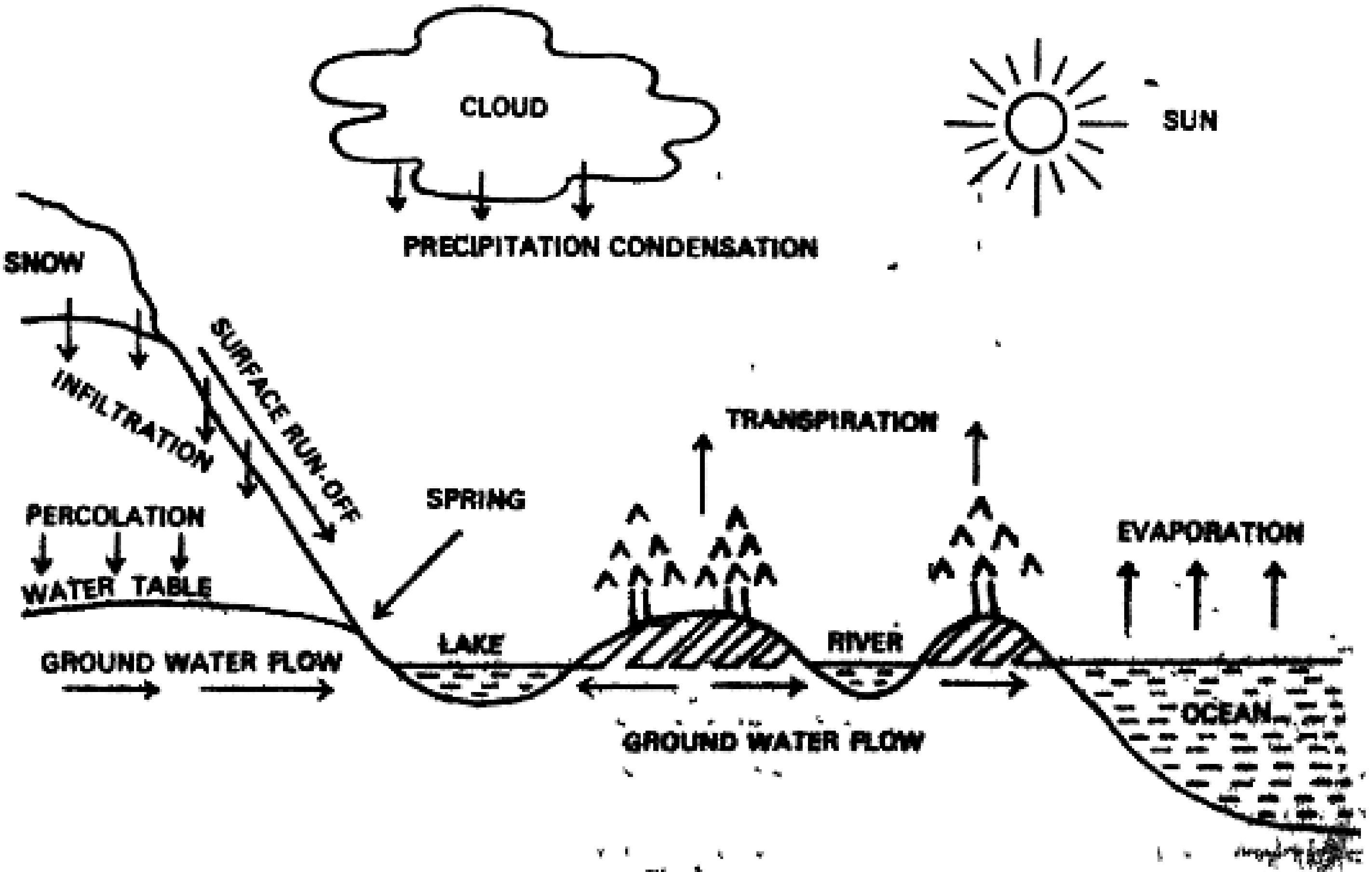

Fig. 1

filtration, percolation, storage and run-off. The cycle of activities of water extends to a depth of half-a-mile in the lithosphere and to a height of about ten miles in the atmosphere Disruption of this natural chain of events at any stage leads to the draught conditions on the earth

### Hydrologic equilibrium

In terms of hydrologic cycle, for a particular area, a balance must exist between recharge, storage and discharge An equation which explains this equilibrium is given below —

> Surface inflow + Sub-surface inflow + Precipitation + Imported water + Decrease in ground water storage = Surface outflow + Sub-surface outflow + Exported water + Consumptive use + Increase in ground water storage

The amounts of precipitation, evaporation run-off and other quantities in the cycle are not uniformly distributed on the earth either geographically or time wise The hydrologic cycle is directly influenced by the geological history of any particular area If passage of time had created layers of sand and soil of high absorbing capacity, there would be minimum run-off over the ground Here floods are rare and drilled or dug wells would produce a large amount of water On the other hand, if the history had been such that the surface materials were dominantly clay or silt and soil of low absorbing capacity, there would be minimum infiltration and maximum run-off Here floods are very common and drilled or dug wells become dry even in moderate draught conditions

### Relation to various domains of science

Hydrologic cycle reaches into the atmosphere where it embodies the domains of meteorology, hydrometoorology and climatology

In the hydrosphere, the cycle covers the domains of potamology (study of streams) limnology (study of lakes), cryology (study of snow), glaciology and oceanography

In the lithosphere it is directly connected with agronomy hydrogeology (geologic aspects of water), geohydrology (hydrologic aspects of geology) and geomorphology (morphological features of the earth)

As water effects plants as well as animals, the cycle extends into plant ecology and hydrobiology

### Significance

It has an important influence in agriculture, forestry political science (water law and policy), watershed management, geography, economics (hydroeconomics) and sociology

It has many practical applications in structural design, irrigation, hydropower, water supply, drainage, flood control sediment control, salinity control, navigation, erosion of soil, recreation use of water fish and wild life reservation and coastal works

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# How food controls population

OBSERVATIONS on animals in relation to their environment present some interesting facts Nature has great influence over the population size of some particular groups of individuals One of such amusing relationships has been noticed by A Starker Leopold of the University of California, U S A and his colleagues between the California quail, *Lophortyx californicus*, and the plants forbs on which they feed In dry years, when the forbs are stunted breeding in quail is irregular According to them, the stunted forbs contain high levels of oestrogens phytoestrogens, that inhibit reproduction in the birds The fast growing plants, however do not contain phytoestrogens

Earlier it was believed that vitamin A, obtained from the green food plants and stored in the liver of the birds, plays an important role in breeding of these arid land quails When vitamin A was supplemented in the food experimentally, it did not show any effect on the breeding potentiality Reports however, already existed that phytoestrogens from subterranean clovers inhibited breeding in domestic sheep This information lead Leopold and his colleagues to investigate whether there is any such compound in the food plants of quails They indeed found four isoflavones—Biochamin A Genistein Daidzein and Formononetin, besides Coumesterol (the estrogen found in subterranean clovers) in several food plants of quails

During investigation the scientists fed two groups of birds with two different types of food One group (control birds) was given commercial turkey feed containing 26°, crude protein and another group (experimental birds) with turkey feed plus subterranean clover extract containing Biochamin A Genistein and Formononetin The control birds bred one month earlier and produced twice as many eggs in comparison to the experimental quails.

Leopold and his colleagues then examined the crop (part of the alimentary canal) contents of wild birds shot between 1972 and 1973. In 1972, a dry year, there were plenty of forbs but with stunted growth and many birds stopped breeding by June The quails produced only 25 offsprings per 100 adults The phytoestrogens—formononetin and genistein, were found to be consistantly present in birds' crop. However, in wet summer of 1973 when the growth of the forbs was lush and hatching continued upto September, the quails produced 325 offsprings per 100 adults. The phytoestrogens were virtually absent in their crop contents.

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# A desert shrub with industrial potential

THE leafless stems of Candelilla, an exotic desert shrub, exude a white wax known as Candelilla wax that has valuable industrial potential It makes good forage for goats and rabbits It was introduced in India at Central Arid Zone Research Institute Farm, Jodhpur in 1963 Since then it has well acclimatised to the Indian arid conditions

**Distribution**

*Euphorbia antisyphilitica* Zucc (Syn *E cerifera* Alcocer) (*Euphorbiaceae*), is native to the North American arid lands It is found growing wild in abundance from the Big Bend area of Texas and Southern New Mexico to Coahuilan desert in Mexico Although wild types have been harvested often, Candelilla is being domesticated into a crop for systemic exploitation.

**Botany**

Candelilla is a hardy perennial shrub with bushy habit due to repeated branching of the stem from the base (Fig 1) The stems are erect, slender, cylindrical, glabrous, succulent, with an outer waxy cover. Leaves are much reduced, simple, linear, whorled and are usually deciduous. Inflorescence terminal on short flowering branches Flowers unisexual, male and female on separate cyathia. The tricarpellary ovary has single ovule in each locule and lobed stigma (Fig 2) Vegetative propagation is by stem cuttings

**Table 1. Yield data of single plant**

| *Plant age* | *Dry weight (kg)* | *Wax yield %* |
|---|---|---|
| 1 year | 0 45 | 2.8 |
| 2 years | 2.57 | 2.6 |
| 16 years | 16 0 | 2 5 |

**Cultivation**

Requiring only 100mm-500mm of annual rainfall, it grows best on rocky, sandy slopes in soil that is well drained and poor in humus The plants can be easily propagated from stem cuttings placed in moist

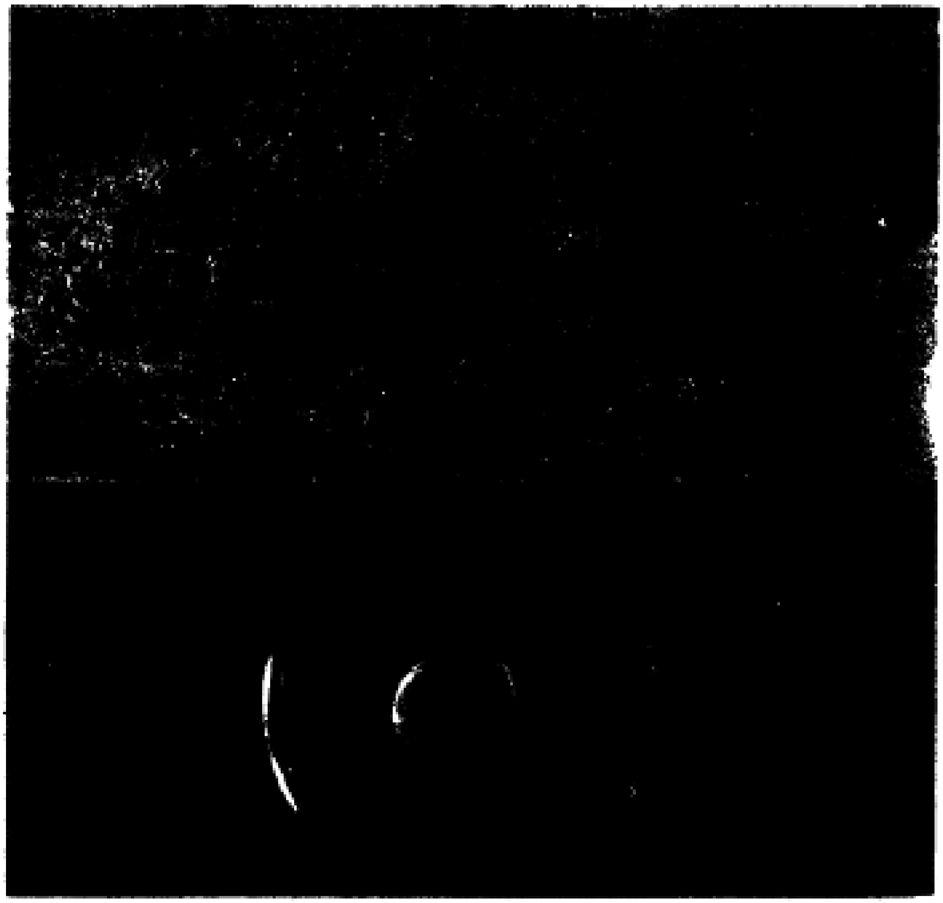

Fig. 1 Candelilla plant and its wax

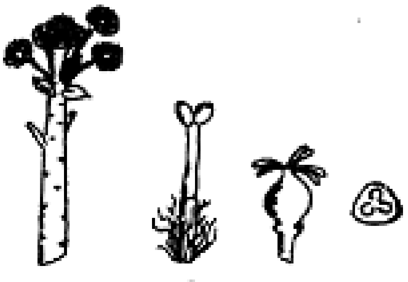

Fig. 2. Floral structure

soil. In 1978, 95% survivability was recorded at Jodhpur. It requires 2-5 years to produce wax in sufficient quantities for commercial use. After harvest, the remaining stems may be allowed to regenerate. The plant does not seem highly susceptible to diseases or pest. The waxy coat is reported to be thicker in drier months and drier areas. Yield data for single plant of different age groups is given in Table 1.

### Extraction and refining

When dried stems are boiled in water with a little sulphuric acid, about 2 per cent of the plants weight is obtained as wax. Better wax yield is possible by extracting crushed dried stems with petroleum ether in a soxhlet for 36 hours. Crude wax separates on concentration. It is an amorphous solid, yellowish brown in colour. Further refining to remove water and resin is necessary for commercial utilisation and this refining process has also been standardised.

### Utilisation

Synthetic waxes, largely based on petroleum, have not yet replaced natural waxes. With ever-increasing cost of petroleum, a continuing market for natural waxes is foreseen. Candelilla wax is a high melting natural wax and is a substitute for both beeswax and carnuaba wax. It even appears a cheaper and superior wax compared to carnuaba. Refined candelilla wax is used as a hardner for soft waxes in candles, polishes, chewing gum, leather goods, varnishes, lacquers, sealing waxes, paper sizing, dental molds and electrical insulating materials. It is also utilised in the manufacture of explosives for defence purpose.

### Conclusion

The yield and quality of Candelilla wax obtained from Jodhpur grown plants is good and conforms to the specifications of both commercial grade Mexican wax and cordite factory. At present, cordite factories in India import Candelilla wax for their production, price being Rs. 68/- per kg in 1978. Hopefully, we can look forward for developing an indigenous source of Candelilla wax not only for cordite factory but also for polishing, coating and chewing gum industries.

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## MEDICAL NOTES

*(Continued from page 736)*

onset of myocardial infarction symptoms, reaches a peak in 30 hours and then subsides to normal in two to four days. The magnitude of the elevation is greater than the rise in S.G.O.T. and S.L.D.H. levels. The C.P.K. determination in serum of the patient is a very sensitive indicator of heart damage, but it is affected by previous vigorous exercise, thyroid status and intramuscular infections. So, a single abnormal value cannot be relied upon in the absence of other confirmatory evidence.

In a comparative study of the diagnostic enzymes of heart disease, it is observed that levels of serum C.P.K. and G.O.T. rise sharply but briefly after a heart attack while serum HBDH and LDH rise slowly and persist for a longer period (Fig. 2). It is customary today to diagnose heart diseases on the basis of the estimation of S.G.O.T. and S.L.D.H. The modern improved biochemical estimations of other serum enzymes provide additional data for a clear picture of the various heart diseases such as angina pectoris, myocardials, pericarditis, pulmonary embolism, etc., as shown in the Table 1.

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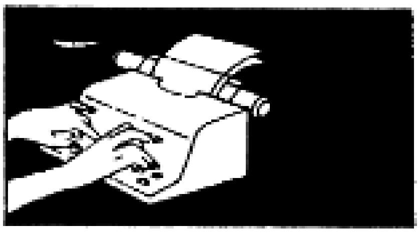
## FLUORESCENT X-RAY

*(Continued from page 715)*

prerequisites of industry —accuracy, speed and economy.

### Further reading

1. Clark, L. George; *The Encyclopedia of X-rays and Gama Rays*, Reinhold Publishing Corporation, New York.
2. Bikks, L. S.; *X-ray Spectrochemical Analysis;* Interscience Publishers; New York, 1960.
3. Schall, W.E.; *X-rays—Their Origin, Dosage and Practical Application;* John Wright and Sons Ltd., Bristol
4. Harby, John H. & Wimberby, Stephen, E.; *Instrumental Analysis;* John Wiley & Sons, Inc. New York.
5. Clark, L. George; *The Encyclopedia of Spectroscopy*, Reinhold Publishing Corporation, New York.



# NEWS & NOTES

## Nobel Prizes 1980

### Physics

ABOUT 15 billion years ago, the universe was formed out of the "Big Bang" A terrific explosion took place in which matter was thrown away in all directions, which subsequently cooled and collided to form the galaxies, stars, planets, etc. According to the basiclaws of nature, what are knownas "Symmetric principles", both matter and anti-matter were produced in equal amounts during the "Big Bang". But it is as well true that when matter and anti-matter meet, they annihilate each other completely. To explain the existence of the present universe was therefore a puzzle for physicists : Why the universe did not destroy itself just when it was born out of the "Big Bang"? Suppose, in case, the universe was not able to destroy itself, what happened to that large amount of anti-matter? To date, the physicists have not been able to trace a lump of anti-matter in this matter-predominating universe! The answer to this anomaly came in 1964, when a team of four physicists, James W Cronin, Val L. Fitch, Rene Turley and James Christenson made a classic discovery at the Brookhaven National Laboratory in New York, U S A

According to the "Symmetric principles , all the laws of nature are equally applicable to the matter and the anti-matter. At the grass-root level, in all the nuclear-reactions all the particles can be replaced by their anti-matter opposites—for example, a positron (negative electron) can replace an electron. Also, there is no difference between nuclear processes and reactions and their mirror images, which, in other words, means that if a film of a nuclear reaction or process is taken, to study it it hardly matters whether the film is run either forwards or backwards. Isolated variations were found in the behaviour of various basic reactions and particles, but, on the whole, the laws were presumed to be inviolable. The aforementioned team of physicists was tackling these aspects of the "Symmetric principles" in the behaviour of the fundamental particles when it stumbled across something quite unexpected. The team found that the K-meson, a neutral unstable nuclear particle with half the mass of a proton and very short life-time, did not obey the natural laws two times in every 1,000 reactions The nuclear particle decayed into a pair of $\pi$-mesons (pions) instead of decaying into three pions as per the laws of nature. To discover so minute a violation of the laws of nature was indeed a wonderful achievement, but still more wonderful was the effect it had on the understanding of the universe.

It is apparent from the violation of the principles of symmetry that nature favoured matter more than anti-matter So within the first few seconds of the "Big Bang" the formation of matter went on at a higher pace than anti-matter, the result of which was that when matter and anti-matter of equal amounts were annihilated, just enough was left over to form the universe that we see today The violation of the symmetric principles has also a bearing on other related fields; for example, it leads to the possible violation of the time-reversal phenomenon, which, what it exactly means is not yet clear; it also lends support to the six Quark theory of matter. According to the theory, matter is built up of fundamental six particles, called Quarks.

The Royal Swedish Academy says that the two American physicists James W. Cronin of University of Chicago and Val L. Fitch of Princeton University have been awarded the 1980 Nobel Prize in physics for their aforementioned discovery which is an "important step in the understanding of matter and life on earth". There is some unhappiness in the physics community as to why René ,Turley of the team, who had then come to Princeton University

Nobel Laureates-Physics : Val L. Fitch (*top*) and James W. Cronin (*below*) on a leave of absence from the Center for Nuclear Studies, France, had not been allowed to share the Prize. The omission of James Christenson is understandable because at the time of discovery he was a graduate student.

### Chemistry

Genetic engineering is a much talked about subject today, and why shouldn't it be? It is likely to revolutionize not only biology but also the future lives of homo sapiens. No surprise that the latest Nobel Prize in chemistry has been awarded to three molecular biologists, whose researches have brought genetic engineering to a pass undreamed of only a decade back. Biologically speaking, gene, whose manipulation is termed "genetic engineering", is the carrier of heredity in all living beings. But at the chemical level it is the DNA (Deoxyribonucleic acid) molecule that is the carrier of heredity in the cell machinery of any living being. So it will be the DNA which would be the central figure in the elucidation of the research work of the latest Nobel Prize winners.

A DNA molecule is composed of two strands, which are built up of four chemicals, namely, Adenine, Guanine, Cytonine and Thynine The two strands are intertwined, one strand exactly complementary to the other, like the opposite teeth of a zip fastener. The four chemicals are considered to be the basic building blocks which produce life in all its splendour and variety as seen on the earth The four chemicals are thus also the basic alphabets of heredity, whose number and the order in which they are arranged, determine the chemical instructions required in the functioning of the cell machinery in a living being and the further propagation of its hereditary characteristics.

When the DNA has to give some instructions to the cell machinery, the strands uncoil themselves. One of them, then, goes on to produce its complementary strand with the use of some chemicals and passes this newly produced strand on to the cell machinery. With the proper chemical instructions written in its alphabets, the new strand then executes the work in the cell machinery for which it was produced. This, in short, is the manner in which DNA controls the various hereditary characteristics in a human, or for that matter, any living body. If, by chance, there is some defect in the alphabets and thus in the chemical instructions, the body suffers accordingly. Such diseases in the body are called genetic defects

Nobel Laureates—Chemistry Paul Berg (*left*), Frederick Sanger (*right*) and Walter Gilbert (*inset*)

To understand the instructions written in a strand of DNA, the number of alphabets of heredity and their arrangement or order in the strand need to be known. A virus like Phi-X 174, which is a very primitive form of life, has genes, which contain no less than 5,386 alphabets of heredity. On the other hand, a human being contains a thousand million such alphabets. So, to decode or identify the alphabets, their number and order, which means to understand the instructions, is an arduous and painstaking task Half of this year's Noble Prize money has therefore been shared by Frederick Sanger of Cambridge University, England, and Walter Gilbert of Harvard University, U.S.A., who have both developed techniques for decoding the gene or DNA While Sanger's technique is biological in nature, Gilbert's is chemical In the former technique, enzymes, the biological catalysts, are used and in the latter chemical reagents By the use of these techniques it is now possible to decode about 1,000 alphabets of heredity from a DNA strand in one day; while, earlier, only 50 alphabets could be decoded in one year.

### SANGER'S SECOND

Frederick Sanger becomes the second scientist to win the Nobel prize twice in the same subject. Earlier the U.S physicist John Bardeen, who invented transistor won two Nobel prizes in physics. Two other scientists who won two Nobel Prizes but in two different subjects are Marie Curie and Linus Pauling.

The other half of the Nobel Prize money has been awarded to Paul Berg of Stanford University, U.S.A. Berg could easily be called the "Father of Genetic Engineering" because he invented the technique of gene-splicing, which literally means joining together of the various pieces

Nobel Laureates –Medicine · George Snell (*left*) Jean Dausset (*middle*) and Baruj Benacerraf (*right*)

of gene or DNA Berg and his colleagues discovered enzymes which could help them in making tailor-made genes Whereas one set of enzymes could easily cut the genes into pieces another set could patch or join them up to form new genes not found in nature In other words, it is now possible to produce new species of beings or beings with new characteristics and functions for the benefit of the mankind Also, gene-splicing technique enables scientists to isolate a specific gene and thus understand the chemical instructions expressed by it Such studies would help in removing genetic diseases and cancers that afflict the mankind

**Medicine**

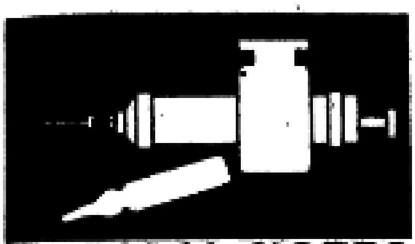
Whenever any foreign agent, namely chemicals, bacteria, virus, enter a living body, the latter resists its presence and in the process eliminates it The body produces certain chemicals, called anti-bodies, which conduct the extermination of the agent But there is every possibility that a living body may not have, so to say, the equipment to exterminate a foreign agent In such cases it becomes ill and even may die When the body has the basic equipment to fight a certain foreign agent it is considered to be "immune" to that agent In recent times it has been found that a set of genes controls the immunity equipment in the body In other words, a human, or for that matter any body is hereditarily immune or not immune to a particular disease or diseases

So if the genes that instruct the body to fight a particular disease or diseases are identified, scientists can use the knowledge to rectify those genes in human beings who are afflicted due to them. There are about 30 such genetically caused diseases in human beings, for example, multiple-sclerosis, rheumatoid arthritis, juvenile diabetes Apart from a body becoming immune to foreign agents, which is quite natural, it is also possible that it may become immune to its own agents, i e , "self-molecules" In such a case the body would possess a self-afflicted disease, which may eventually lead to its death Only genetic manipulation can then save the body from a chronic disease or death So the study of links between genetics and immunology is likely to make mankind free of the aforementioned illnesses and deaths Three scientists have been awarded the 1980 Noble Prize in medicine for their research work in establishing the links.

Research work on the links between a body's immune system or equipment and genes, however, began in a slightly different field. In the early 70s, George Snell of the Jackson Laboratory, U S.A., was studying what makes a living body accept or reject a foreign organ or tissue transplant. In other words, he was trying to find how a body recognises what are its "self-molecules' (or tissues or organs) from those which are of another body His motive was to see if genes play any role in deciding this issue His method was to breed mice with almost identical genes except one He studied whether one different gene in any way influences the body of a mouse to' accept or reject another mouse's tissue, and he found it to be so He found that a particular set of genes plays a more important role than others in controlling the immune response of a mouse to the transplantation of a foreign tissue

Subsequently, Baruj Benacerraf of Harvard University, U S A , showed that a particular dominant gene which he called "immune-response gene, controls the immune response of a mouse to a foreign agent, whether a virus, a tissue or chemicals He arrived at this conclusion by feeding a laboratory-made foreign agent to guinea pigs and mice He also studied in minute details how genes manage to influence the immune system to exterminate a foreign agent in the body However, all these aforementioned observations are based on the studies of animals It was the French doctor Jean Dausset of Saint Louis Hospital, University of Paris, who took the giant leap, he discovered a similar set of "immune response" genes in the human body Credit also goes to him for introducing the culture techniques in such studies, which have speeded up research in the field. Besides he has also classified human tissues into groups for successful organ or tissue transplantations, just as there are blood groups for successful blood transfusions.

DILIP M SALWI



**MEDICAL NOTES**

# Diagnostic enzymes in heart diseases

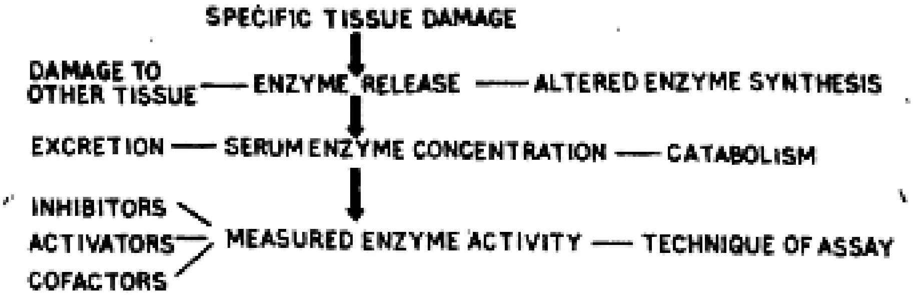


Fig. 1. Tissue damage and enzyme release mechanism

THE measurement of enzyme activity in tissues and body fluids provides a significant aid in the diagnosis, prognosis and treatment of diseases of various organ systems. Enzymes have two properties, catalysis and specificity, which set them apart from other biochemicals measured in clinical laboratories. As a result of catalysis, enzymes can be detected and measured precisely in tiny quantities by virtue of large chemical changes they induce. Because of their specificity, they perform tasks restricted to certain sites, and are localised in certain cells and organs.

The sudden and complete blockage of a coronary artery by thrombosis, for example, cuts off the blood supply to a zone of myocardial tissue (heart muscle) depriving it of oxygen and glucose. As a result of tissue damage the patient suffers chest pain. The disintegration of the affected muscle leads to a sudden release of the cardiac (heart) enzymes into the circulation (Fig. 1) and these are removed at different rates from the plasma/serum. The increase and removal of some of the serum enzymes is characteristic and is the basis of identification of several diseases of heart (Table 1).

The electrocardiogram (E.C.G.), the most popular means of diagnosis of heart diseases is fallible as it does not reveal the condition of the heart in a number of situations. For example, in hearts previously damaged by an infarction, the old changes often obscure the recent electro-

Table 1. Enzyme diagnosis in cardiac disease

| *S. N.* | *Enzymes* | *1st 4 days* | *5-10 days* | *Over 10 days* | *Remarks* |
|---|---|---|---|---|---|
| 1. | SGOT | Moderate to marked elevation 3 × Normal | Slight or normal elevation | Normal unless reinfarction | Must exclude hepatic disease, cholecystitis muscular disease, infectious mononucleosis, false positive results due to drugs including anticoagulants. |
| 2 | SLDH | Moderate elevation | Elevation | Normal or slight elevation | Must exclude pulmonary infarction, leukemia, carcinoma, megaloblastic anemia (Isoenzymes useful) |
| 3. | SCPK | Marked elevation | Normal | Normal | Specific except in muscle disease |
| 4. | SHBDH | Moderate elevation | Elevation | Elevation | Highly specific although elevated in hepatitis, and renal infarction |
| 5. | Serum aldolase | Moderate elevation 2 × Normal | Elevation | Elevation | Highest value in muscle disease |
| 6. | Serum malic dehydrogenase | Slight to moderate elevation | No change | No change | Elevated in hepatic disease and carcinoma, less specific than LDH |
| 7. | SGPT | Slight change unless heart failure | Slight change unless heart failure | No change unless heart failure | Elevated in hepatic disease; shows more change after drugs and anticoagulants than SGOT (elevated SGOT with anticoagulants in the presence of normal SGPT significant for cardiac necrosis) |

cardiographic picture. In myocardial infarctions which are intramural (changes inside the heart blood vessels but without blockage) and in which 'Q' wave changes do not show up in E.C.G., serum enzyme determination can be utilized for a clear picture of the cardiac malfunctions. There are several serum enzymes that can be used for the study of heart diseases (Table 2).

Serum glutamic-oxaloacetic transaminase (S.G.O.T.) is the most common enzyme used for diagnosis of heart disease. The concentration of this enzyme is very high in hearf muscle (myocardium) and it rises sharply in serum of the patient within the first 12 hours after a myocardial infarction (heart attack) and persists upto three to five days. S.G.O.T. levels of over 350 I.U. (one I.U. is equivalent to the enzyme activity present in one litre of the serum) are usually observed after a massive infarction; levels of over 150 I.U. are associated with high mortality and levels below 50 I.U. with low mortality. High levels of this enzyme in serum also occur in the absence of any E.C.G. changes. In such cases the enzyme diagnosis provides an earlier clue to acute myocardial damage. The highest incidence of the abnormal S.G.O.T level occurs on the second day after the attack.

Serum lactic dehydrogenase S.L.D.H is found in varying concentrations in all tissues of the body. The increase of L.D.H. in the serum may follow tissue injury often nonspecific in diagnosis. The S.L.D.H. rise after a heart attack is of diagnostic value only when other causes of tissue injury have been excluded. The rise in level of this enzyme in serum is noteworthy within 12-24 hours after myocardial infarction. It may persist for more than a week, even after the S.G.O.T level has returned to normal.

Table 2. List of important diagnostic enzymes

| S No | Name of the enzyme |
|---|---|
| 1. | Serum Glutamic-Oxaloacetic Transaminase (SGOT) |
| 2. | Serum Lactic Dehydrogenase (SLDH) |
| 3. | Serum Lactic Dehydrogenase Isoenzymes (SLDH isoenzymes) |
| 4. | Serum aldolase |
| 5. | Serum Malic Dehydrogenase (SMDH) |
| 6. | Serum Hydroxy Butyrate Dehydrogenase (SHBDH) |
| 7. | Serum Creatine Phosphokinase (SCPK) |

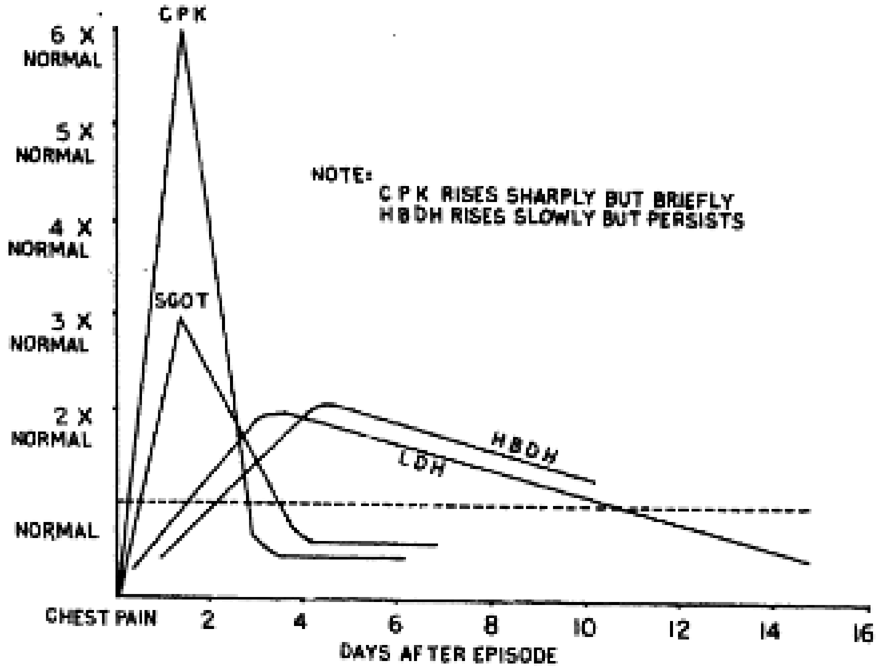


Fig. 2. Typical changes in serum enzyme levels following myocardial infarction

Serum L.D.H. isoenzymes offer better diagnostic specificity than serum L.D.H. The isoenzymes consist of five different components. They can be separated by putting the serum of the patient in high voltage electrical field (technically known as electrophoresis). The individual components separated by this process may help in differentiating the varied disease processes. The five components are known as $\alpha_1$, $\alpha_2$, $\beta_1$, $\gamma_1$ and $\gamma_2$, of which $\alpha_1$ predominates in heart muscle and damage of this tissue after heart attack results in excess of this component in serum.

Serum aldolase activity, like the S.G.O.T., reaches a peak on the second day after a myocardial infarction and usually returns to normal by the fifth day. The highest abnormal levels are about five times the upper limit of the normal enzyme activity (the normal range is from 1.5-7.0 I.U.).

Serum malic dehydrogenase (S.M.D.H.) is widely distributed and is particularly abundant in heart muscle, skeletal muscle, liver and kidney. Increase and behaviour of S.M.D.H. is some-what similar to the S.G.O.T. and serum aldolase in patients of acute heart attack.

The level of serum hydroxybutyrate dehydrogenase increases after myocardial infarction, and to a lower extent in certain liver diseases (hepatitis). But heart cases can be distinguished from that of hepatitis because the H.B.D.H./L.D.H. ratio is elevated in heart disease and lowered in liver disease.

Heart and muscles are the richest source of the enzyme creatine phosphokinase. The activity of this enzyme in serum has been found to raise within a few hours after the

*(Continued on page 731)*

# SCIENCE FOR THE YOUNG

## Gopal Chandra Bhattacharya —a self-made naturalist

SOME men are born with an unusually keen awareness of nature to spend their lifetime thoroughly absorbed in this single minded career of examining the marvels of the living world. Such, indeed, were the personalities of Charles Darwin, Jean Henri Fabre, Eugene Marais, and Gopal Chandra Bhattacharya.

Darwin is of course known to everybody as the proponent of the theory of evolution. But even apart from this. everyone of his other investigations would entitle him to be a great naturalist. All these, e.g., pollination of the British orchids, the life history of the earthworm and its beneficial effect on the soil, sensitivity of plants to stimulus (his book on this subject is a pointer at the later research of Sir J. C. Bose) and comparison of emotion and behaviour in man and other animals are masterly examples of a naturalist at his best. Written in a sparkling clear language, and a language that is the most well-known in the world, every one of his books contributed to the body of human knowledge. Again Fabre, the "Homer of the Insect World" as termed by Maeterlinck and "the inimitable observer" by Darwin, devoted his declining years of comparative ease after a long bitter struggle against grinding poverty, to the composition of *Souvenirs Entomologiques*, a series of books that presented the fascinating world of insects in a most poetic language. These works, too, were applauded in the whole world, for they were written in French, a most prestigious language. Marais and Bhattacharya were, on the contrary, victims of a communication barrier. Marais recorded his observations in Afrikaaner, a language derived from Dutch, Flemish and Zulu. Published in obscure south African newspapers, they remained mostly unknown to the wide world. Some of these articles are probably lost for ever but luckily some have been collected and translated into English and a perusal of them gives one pleasure. In his later life Marais carried out observations on wild life in South Africa while living alone in a tent. Recently he has become well-known through the widely read books of Robert Ardrey.

Bhattacharya, the Fabre of Bengal, recorded most of his observations in lucid Bengali. This has enriched the language but naturally left no mark on the world at large. Fabre had an Alexendre Teixeria de Mattos to transmit his findings without marring the poetry of the original to a larger circle of English speaking people. Such is not the case with Bhattacharya. Nevertheless, he has about a dozen technical and popular articles in English to his credit. Alone, self-taught and isolated from the mainstream of ethological science then swiftly running in Germany, there was apparently little he could do, but he has done it surprisingly well. He might have ended his career as a clerk in a jute mill or as a village schoolmaster but a very short article written by him on bioluminescence in a Bengali periodical attracted the attention of Sir J. C. Bose who offered him facilities at his Institute. Bhattacharya worked with Hans Mollisch (who visited Calcutta) on problems of bioluminescence but he has no published paper to his credit on this subject.

His first scientific paper seems to be one on aquatic spiders. He had watched and indeed photographed these spiders in some of the innumerable ponds in Dum Dum, near Calcutta. The photographs showing the hunting of *Panchax* (a small fish) by these spiders speak highly of an Indian naturalist in those days. He also succeeded in photographing the small bat (*Pipistrelle*) caught by a spider in a loft in a cow-house.

In those days, the American Museum of Natural History launched a special programme for collecting information on spiders and Bhattacharya published a paper in the famous magazine—*Natural History* (as well as one in *Transactions of Bose Institute*). He was one of the very few Indians at that time who bothered about the world of insects and the like. It is surprising that in a country like India with her rich cultural heritage encompassing a love of Nature as is evident from the concept of *Tapovana* or such tales as *Panchatantra*, people had lost all contact with nature and not accepted this branch of modern science, either. It therefore remained for the Britishers like Sir Elijah Impey to blaze the trail of Natural History in this country. They gathered together Indian artists and taught them to draw and paint realistically and with their help produced beautiful tomes on Natural History.

Anyway, Bhattacharya then rushed headlong fashioning out a new career for himself. This, in retrospect, seems to be adding a new dimension to the Bengali language, creating a trend of popular science, which was indeed initiated by men like Jagadananda Ray and J. C. Bose. Scores, perhaps hundreds, of articles were published by Bhattacharya in various Bengali periodicals, articles less poetic than that of Fabre, but equally appealing and with very nearly the same masterly touch. At the same time it should be pointed out that inevitably these suffered from an inherent weakness, that of the lone wolf of modern science. Even a Fabre in the second and third decades of this century had necessarily to be less of a trail blazer than Jean Henri of nineteenth and early twentieth century. Had he the chance of working in the rigorous school of Tinbergen or Lorenz or Von Frisch, or their teachers or peers like Heinroth, Uexkuell or Otto Kochler or the Gestaltist W. Koehler of chimpanzee fame, Bhattacharya might have earned world-wide fame.

Anyway, I am now concentrating on only three of his discoveries which, I feel, are of unusual interest. The first of these is concerned with a species of tree ants. These large sized ants construct nests out of leaves resembling birds' nests. In order to study the ants inside the nest he invented a simple but ingenious device, namely, he encouraged the ants to construct nests with the help of pieces of transparent cellophane. He could then see the ants inside the nests and continued the observations over 2-3 years. The number of kings, queens, workers and soldiers born in each nest was noted and recorded. As is well-known, apart from the male and female, ant society also boasts of workers and soldiers. How can these organisms with their considerably different morphogenetic patterns be born out of the same genetic stock (of normal females and males)? Some scientists were of the opinion that the different patterns of morphogenesis arise out of different food and feeding conditions. In case of bees, for example, it was known that special food like the Royal Jelly is necessary for making a queen out of a larva with the potential for becoming a female. Without this food the larva would turn into a worker. But some scientists, e.g., Haydak, thought that the quantity of food is more important. In case of ants, Wheeler, the great entomologist of that time, did not ascribe much importance to the "trophic" theory, i.e., the state of nutrition being the determinant factor. Bhattacharya investigated this aspect and found compelling evidence for this theory. He prevented the ants from foraging and collecting the food they would normally obtain and fed them with artificial food. Even with very protein rich diet no kings and queens were born in the nests. But on being presented with the newly sprouting leaves and buds of mango and some other trees in the summer season only, the ants produced males and females. Under natural conditions the ants do forage and eat these leaves in summer.

Today, the science of heredity has reached the level of molecular genetics but even here this trophic theory poses an important question. We may recall that the larvae of certain marine snails require certain special food items, algae or small coelenterates, in order to be able to metamorphose. Perhaps in future one can study the effect of such food on the DNA of the organisms (larvae of ants or of those snails) and shed light on the morphogenetic patterns induced thereby.

Unfortunately, the findings of Bhattacharya published in the *Transactions of the Bose Institute* during the sombre period of the Second World War remained largely unknown. Because of the war the results did not come to the notice of the Germans. From 1937 to 1947 Goetsch in Germany had been studying similar problems and his conclusions have a certain resemblance to that of Bhattacharya. Goetsch found that certain substances from yeast, fungus, etc., induce the larvae to develop into special castes. On checking his dates one can see that Bhattacharya's conclusions were arrived at two or three years earlier than that of Goetsch. However, Goetsch's findings, too, have not been conclusively proved or repeated later. In 1940 Wesson in England carried out an

Gopal Chandra Bhattacharya

interesting observation on two species of ants the larvae of which are distinguishable because of their black and yellow colour, respectively. By interchanging the larvae in different nests one could see that transferring to nests provided with richer food leads to a higher production rate of queens. *Social Insects* by Wilson is a Bible for the student of entemology today. Wilson has referred to the work of Wesson and Goetsch but he did not have the opportunity of coming across the paper of Bhattacharya. (The author has recently received a letter from Wilson stating that he considers the paper of Bhattacharya to be a sound piece of pioneering work but that Wilson's own results on African ants are different).

Let us now come to the second discovery of Bhattacharya. At Gombe Research Station in Tanzania, Jane Goodal - Lawick and her group have observed chimpanzees. These chimps not only use but make tools. Koehler, the famous psychologist, of the Gestalt school, had of course reported tool using in captive chimpanzees long ago. But the wild Gombe chimpanzees first revealed to us their near human intelligence in fashioning a stick out of a branch of tree and digging out the ants and termites which they then eat with gusto. Likewise, they can make a spongy end to a leafy branch by chewing and thus soak water out of an inaccessible hole. (Bert Haanstra has shown the first of these two tool using behaviour in his famous film—Ape and Superape). Let us follow Goodal to the vast plains of Serengeti and switch our attention from chimps to Neophrons or Egyptian vultures or Pharaoh's chicken.* They too use tools (though they cannot make one). They pick up stones and strike at the ostrich eggs and break open the shells before eating.

Even the lowly insect may use tools. Many years ago Peckham described how an American hunting wasp uses a small gravel chip as a hammer and beats flat the closed entry of the hole wherein she had laid her eggs and a food supply for the future larvae. Bhattacharya discovered the same method in another species in Bengal. But a more interesting case is that of the earwig. Naturalists know that they take care of their eggs. Bhattacharya noticed that only during this "brooding" period they carry a muddy layer on their hind legs. The mud soon dries up and forms a heavy boot, as it were, for the formerly naked legs. The insect savagely strikes out with the hind legs when the need arises for protecting her eggs. If the mud is washed away by squirting water through a pipette it promptly wallows in mud again and forms a new plaster! Outside the brooding period they do not wear such boots.

The third important work of Bhattacharya involves tadpoles. Every year tadpoles in their millions metamorphose into froglets. This commonplace phenomenon is no less wonderful than, say, the transformation of the mermaid into a human princess in the tale of Hans Andersen, for, a tadpole, with its tail and breathing like a fish is transformed into a tailless frog that breathes on land. We know that thyroxin (or iodine) is necessary for this transformation. But Bhattacharya noted the strange fact that treatment with penicillin prevents the metamorphosis of these tadpoles. They continue to remain as tadpoles. At that time the late Sir Julian Huxley visited Calcutta and was deeply impressed by this finding. It may be recalled that Huxley himself unravelled the mystery of the neotenous mexican axolotl which too can promptly metamorphose on treatment with iodine or thyroxine—a process of metamorphosis they had forgotten for centuries. Huxley suggested that the results of Bhattacharya be submitted to the famous British journal—*Nature*. (This was however never done.)

Bhattacharya and his colleagues then showed that penicillin destroys or inhibits certain bacteria in the tadpole's body which synthesize a large amount of vitamin $B_{12}$. Treatment of penicillin-inhabited tadpoles with this vitamin helps them metamorphose. Bhattacharya and his colleagues noted further that at a certain age, treatment of arrested tadpoles with vitamin enables them to grow frog-like legs but the gills and tails persist. The effect of penicillin on the tadpole liver is to reduce acid and alkaline phosphatase but vitamin $B_{12}$ induces the opposite trend, namely, it enhances the phosphatases. These results were published in *Science and Culture*.

The new horizon now revealed is the vast world of salogenic bacteria.

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*We have this bird in India too, and the mysterious birds of *Paskhitirtham* are such "white vultures". An Indian ornithologist traced the birds to their nests in neighbouring crags. Thus it stands to reason that territoriality and biological clocks can explain the mystery. Generation after generation two (or one) adult birds, but never four or five, would forage in that area and come to take their *Prasad* at a particular time as many other animals can do.

We know about the disease producing (pathogenic) bacteria but we do not generally realize the vast possibilities of unknown bacteria which may be positively health giving (salogenic). It is well-known that bacteria in the intestine or rumen of animals like gorilla or cow help digest cellulose. But not so familiar to many is the work of Henri years ago. He showed that killing of bacteria *inside* the egg of cockroaches (say, by mild heat treatment) prevents the normal growth of the insects, they remain much smaller. Again, in 1978 Harrigan and Alkon presented evidence suggesting that metamorphosis of certain marine snail larvae depends on the bacteria in the substrate, viz, sea-bottom (sandor mud).

Now an octoganerian, Bhattacharya lives in Calcutta.

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# X-rays

MOST of us know nothing more about X-rays than that they are used to locate fractures or bullets in the human body. Let us try to know a little how they were discovered, what they are, how they can be produced and to what uses they can be put to.

**Discovery**

It was Wilhelm Conrad Roentgen (1845-1923) the German scientist who discovered X-rays in 1895 in the course of a systematic attempt to see if any radiation could traverse matter opaque to ordinary light. While studying the discharge of electricity through gases at very low pressures, he observed that a screen of crystals of platinum barium cyanide covered with opaque paper fluoresced. To his surprise he also found that objects like a bunch of keys, when interposed between the tube and the screen cast their shadows on the latter. It was obvious that the effect on the fluorescent screen was due to some type of radiation sent by the tube. Because of their unknown nature, Roentgen called them "X-rays". They are now sometimes referred to as "Roentgen Rays." Roentgen received the Nobel Prize for his discovery in 1901.

**Nature of X-rays**

The discovery created a great sensation and aroused great curiosity. Consequently, many experiments were performed to elucidate their properties and nature.

It did not take time to know that X-rays were some form of electromagnetic radiations essentially similar to radiowaves, light,etc., although they had a shorter wavelength. Their possibility of being charged can be dismissed from the fact that they are not deflected by either electric or magnetic fields. They travel in a straight line with the velocity of light ($2.9 \times 10^{10}$ cm/sec.) They also affect photographic plates and liberate electrons when they fall on some metals. It was initially thought that X-rays do not show some properties like reflection, refraction, interference, diffraction and polarization; but later experiments have showed that they do exhibit these properties under special circumstances. X-rays ionize the gases through which they pass. They penetrate through matters opaque to light.

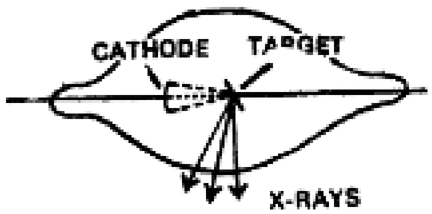

Fig. 1

**Production**

X-rays are produced whenever cathode rays (electrons) strike a piece of matter and so are brought to rest. The production of X-rays is analogous to the noise produced when a steel plate is bombarded by bullets from a rapid fire gun. The bullets correspond to the cathode rays and the noise to the X-rays.

The tube which Roentgen used to produce X-rays was rather crude. It has undergone refinement and numerous modifications; nevertheless the basic form is the same.

The modern X-rays tube is capable of giving a stronger X-ray beam and is called the Coolidge tube. It consists of a glass globe which is evacuated to a high degree (less than $10^{-6}$ mm of Hg). Cathode rays are produced by the thermionic emission from a heated tungsten cathode.

The target (or anode), on which the electrons fall, can be of any material for research purposes, but in the Coolidge tube it is made of a metal having a high melting point and a high atomic number. Platinum or tungsten may be used. The target is generally inclined to an angle of 45° so that the X-rays obtained may come out in a perpendicular direction. There is a cooling device associated with the tube which cools the target. In addition to the tube itself another part of the apparatus is a scource of high potential. Its function is to accelerate the cathode ray electrons.

**Applications**

Besides X-rays no other radiations have been put to so many diverse applications particularly to human service.

**Medicine**

(*i*) *Diagnosis*. X-rays are stopped by heavier substances such as bones and cast shadows when such substances fall on their way. It is this property which is made use of in a radiograph or an X-ray photograph.

A radiograph is taken out so as to detect the presence of fractures; presence of foreign matter like bullets in the human body; diagnosis of tumours, ulcers, tuberculosis; stones in kidneys, gall bladders; diseases of the liver or alimentary canal, etc., and healing of bones.

In 1895, X-rays began to be used in surgical operations in Vienna. Not very much later, Morton of New York produced a radiograph of an entire skeleton of a fully clothed adult. For most purposes a potential difference of 50,000 and 90,000 volts generate rays of sufficient hardness.

Apart from the bones the differences of density between the different parts of the body are very slight and it is not normally possible to distinguish details of the soft organs—stomach, liver, blood vessels, etc. However, doctors introduce a harmless compound containing a dense element. To observe the stomach and intestinal tract, for example, the patient is given a barium meal consisting of a paste of barium sulphate and water. Each part of the alimentary canal shows up clearly as the barium meal reaches it. Radiographs can be taken easily by such techniques to locate any abnormality in the body.

(*ii*) *Treatment*. (1) Treatment by X-rays depends upon the fact that a diseased tissue (malignant growth) is susceptible to destruction to a greater degree than the surrounding healthy tissue. In order to reach the deep seated tissue with a minimum destruction of the skin, very hard X-rays are applied. Treatment by X-rays is known as radiotheraphy.

(2) In engineering, radiographs are used for testing weldings, moulds and metal castings, and detecting faults in finished products.

(3) Radiographs are used in criminal investigation departments for detection of explosives or contraband goods concealed in wooden cases or leather bags; of diamonds or gold in the human body; in testing the genuineness of precious stones and examining the contents of parcels.

(4) In industry X-radiographs are used in the examination of rubber tyres, golf balls, etc., detecting flaws in finished products and also the presence of pearls in oysters.

(5) In art X rays are used to detect changes in old art paintings.

(6) In scientific research X-rays are used for investigating structures of crystals, internal structures of atoms, etc.

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# Brain teasers

**1. Make connections**

Fig. 1 shows six points lying on the sides of a rectangle and four points lying inside it. The points are labelled by the letters A,B,C,D, and E. Corresponding to every letter there are two points. You are required to draw five non-intersecting lines within the rectangle each connecting a pair of points bearing the same letter. The lines need not necessarily be straight.

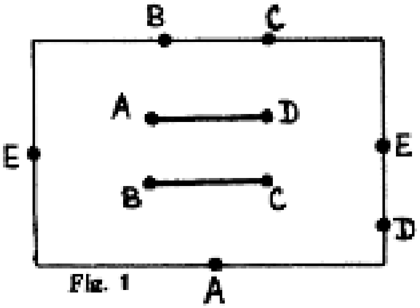

Fig. 1

**2. The fruit vendor**

Ramu, the fruit vendor, was carrying a basket full of oranges on his head to sell them. To his first customer he sold half an orange and half the oranges that he was carrying. He then sold to his second customer half an orange and half of what was left in the basket; and to the third customer he again sold half of what was left and half an orange. Three oranges remained in the basket. How many oranges did the basket contain originally if Ramu did not have to peel any of his oranges ?

**1. The house number**

A certain house number in a particular locality may be found from the following information : If that number is divided by 2 and the result turned upside down and then divided by 6, a prime number is obtained which reads 13 if the digits of this number are reversed. What is the house number if the locality in question has only limited houses whose numbers range between 1930 and 1970 ?

**4. Boys and the stamps**

The two brothers Rohit and Amit have keen interest in collecting postage stamps. The other day when their uncle visited their home, he distributed between them hundred foreign postage stamps. Now, if the number of stamps received by Rohit be increased by one third, it would give the square root of the product of the number of stamps received by each of the boys. How many stamps did Rohit and Amit receive from their uncle ?

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(*Solutions on page 716*)

# FOR HER

## Cooking for better nutrition

COOKING today is a full-fledged art and a science. The culinary art can create a wide range of foods from even one single raw material. For instance, wheat on cooking can give bread, biscuits, cakes, *chapaties*, *upma*, doughnut, buns, pancakes, macaroni and breakfast cereals, to mention a few. Each one is a fascinating study in appearance, feel, digestibility and palatability, thanks to the valuable contribution of our food chemists and technologists

What exactly is cooking? In simple terms, it means subjecting the food to a high temperature in a suitable medium in order to get an acceptable end product. Foods in general contain carbohydrates, fats, proteins, minerals and vitamins, which on cooking undergo various interesting changes, generally useful but sometimes harmful. The useful effects of cooking are: it kills most bacteria, makes the food more easy to masticate and digest by breaking cell walls, altering its texture and by stimulating digestive juices. It also improves the keeping quality of foods. Fruits and vegetables available in plenty during their respective seasons can be processed by special techniques of cooking and preserved in sterilized bottles for use during off-seasons. Sauces, ketchups, pickles, *chutneys*, *murabba*, jams, jellies, marmalades, crystallized fruits, cordials, syrups, crushes and various beverages can be made from suitable fruits and vegetables.

The various methods of cooking commonly used are; boiling, steaming, stewing, frying (shallow and deep frying), roasting (spit roasting, oven roasting and pan roasting), broiling or grilling and baking.

During cooking, a certain amount of the nutrients present in the food is lost, the actual loss depending upon the amount of water used, the duration of the cooking and the surface area exposed. The maximum loss of nutrients occurs during cooking by boiling because it involves direct contact with appreciable volumes of boiling water for a prolonged period, during which time water-soluble vitamins are leached out and proteins of animal foods may denature and harden. Because of the low temperature used (only around 100°C) in normal boiling the time of cooking is long and nutrients and texture suffer damage, flavour is lost and the food may become difficult to digest. If the food is not permitted to come in direct contact with water, as in steam-cooking, there is minimum loss of nutrients and less risk of overcooking and hardening of the proteins of animal foods. Steamed food is also lighter and more easily digestible as compared to food cooked in other ways. But only tender foods such as *idlies*, vegetables, fruits and puddings are usually steamed. Tough foods like dry beans and meat need pressure-cooking, i.e., cooking with steam under pressure at a higher temperature (115°-200°C).

Pressure cooking has a number of advantages; it saves time, fuel and nutrients while making the food tastier. To extract nutrients from tough meat or vegetables, they may be stewed, i.e., heated half-covered with water in a pan with a well-fitting lid. The heat is reduced when the water boils to keep it simmering for a prolonged time. Overcooking must be avoided even here particularly in the case of meat, which would otherwise become tasteless and reduced to rags.

Tender foodstuffs can be steamed as well as fried. Frying is cooking in heated oil or fat. The latter unlike water can be raised to a high temperature and hence the cooking is quick, though it requires continuous attention. For precooked foods like cutlets or foods which need very little cooking like eggs liver, kidney, *dosai* and *appam*, frying in a small quantity of fat in a shallow frying pan or *tawa* is usually followed. To get more uniform results and to prevent the final product from becoming too greasy. Deep frying may be done by immersing the food in a large quantity of hot oil in a deep heavy vessel like an iron *karai*. This method of cooking is suitable for *puri*, *pakora*, *vadai*, cutlets or fillet of fish. The following safeguards while frying will give the best results.

(1) Take fresh, clean fat or oil to start with, and later add more as and when required.

(2) Before putting in the foodstuff, make sure that the fat is hot enough (drop some batter and see). If the temperature is not correct, the food will absorb a lot of oil.

(3) Before frying, evenly coat the food with a batter of flour, milk and egg or beaten egg and bread crumbs or besan batter (Bengal gram flour). This is done to protect

the surface of the food from the intense heat of the fat and to prevent the escape of nutrients.

(4) Fry only a few pieces at a time so that the temperature does not come down suddenly.

(5) Turn the pieces over at regular intervals to ensure uniform cooking.

Roasted meat, poultry or game is considered a delicacy with a pleasing flavour and aroma. Tender chicken or mutton may be smeared with a little fat and then exposed directly to a flame with turning and basting at regular intervals. This method is called spit roasting or 'barbecue' and the cooked meat has excellent flavour and is easily digestible. However, the food roasted shrinks appreciably by this method. Oven-roasting is more convenient and economical than direct roasting. Less fuel is required and the shrinkage is less. Meat or vegetable may be roasted by first browning it in fat, then wrapping in an aluminium foil and roasting in a medium oven (300°F-500°F). If oven is not available, pan roasting may be tried.

For very tender foods broiling or grilling is an excellent method of cooking since it is fast and preserves the juices. Broiling or grilling is cooking by dry heat at a high temperature in a grill or heavy pan or direct, on flames. The heat may be applied over or under the foodstuff, which is usually greased if directly heated over a fire. If a pan is used for the purpose, it must be greased to prevent sticking. *Seekh kabab*, *boti kabab*, cheese, tomatoes, brinjals, etc., are usually grilled.

Baking is yet another convenient method of cooking by uniform dry heat from all sides which gives the food a special flavour. However, it is expensive and time-consuming. To compensate for this, constant attention is not required and the product quality is excellent, provided the whole operation is carried out according to instructions, at the right temperature and for the right period of time. The oven should not be opened often to prevent sudden drops in temperature.

Not only the methods of cooking but also the manner in which the foodstuffs are processed before the actual preparation of the food are important from the standpoint of appearance, texture, flavour, aroma and nutrition. Some of our age-old practices such as decorticating and germinating pulses before cooking, fermentation of raw foodstuffs to make preparations like *idli*, *dosa* and *dhokla* and use of whole wheat flour for chapati making are nutritionally sound. In addition, these practices save cooking time and fuel.

Dehusking, for instance, not only makes pulses easier to cook in a short time but also improves the availability of the iron present 4-6 fold according to studies conducted at the National Institute of Nutrition, Hyderabad. The ionisable iron content and hence the iron availability is low in whole seed of Bengal gram, green gram, red gram and *rajmah* due to the presence of tannin in the seed coat. Sodium bicarbonate should never be added to facilitate cooking of dals or pulses or, to preserve their colour, since it destroys most of the thiamine (vit $B_1$) present. On the other hand, if a substance such as tamarind with high acidity is added to cooking water it has a preservative effect on the vitamins.

Germination or sprouting of pulses such as Bengal gram, black gram, green gram, etc., enhances nutritive value by producing vitamin C (where it was virtually absent), and increasing the folate, thiamine and other B group vitamins 2-3 fold. Substances such as phytate and tannins present in the raw seed invariably interfere with the proper utilization of nutrients. These are broken down during sprouting as shown by the increased availability of iron from germinated as compared to ungerminated pulses. Germination also makes the starches in legumes more easily digestible, besides destroying the indigestible complex sugars present which produce gas and distension of the stomach.

Fermentation of the raw food materials is another method of increasing consumer appeal and improving nutritive value In *idli*, for example, the concentration of B vitamins (riboflavin, niacin and to a certain extent thiamine) increases because of the initial fermentation carried out. Antinutritional factors such as phytate and trypsin inhibitors are destroyed during fermentation and the proteins present have been shown to promote better growth.

Trypsin is an enzyme present in our intestines. Some pulses and legumes such as soybean and Bengal gram, and duck's egg contain substances which inhibit the action of this enzyme and hence hinder the digestion of the proteins of these foods.

Some sugars like glucose and lactose form complexes with amino acids such as lysine and these complexes cannot be broken down by the protein-splitting enzymes of the digestive tract. It is therefore advisable to avoid prolonged and vigorous heating of foodstuffs, especially when substances like jaggery are used in the preparation.

Vegetables should be washed first, then peeled and cut only just before cooking to prevent loss of nutrients in the wash water. It is also desirable to cut them into as big pieces as possible and then add them to boiling water and cook for as short a time as possible. If any water remains after the vegetable is cooked, it should not be discarded because it may contain some proteins and mineral salts of sodium, potassium and chlorine, if salt has been used in the cooking. The cooking water is good for soups. A better way of

(*Continued on page 761*)

## Science In Industry

# Methane telemonitoring system

THE Central Mining Research Station (CMRS), Dhanbad, has developed, in collaboration with Bharat Bijlee Limited, Bombay, a singlepoint methane telemonitoring system for continuous surveillance of methane build-up in the underground atmosphere

The system consists of two sets of assemblies. One set is placed underground for sensing methane and transmitting signal continuously to a surface station through cables The other, installed in the surface station, receives and records the conditions of the underground air continuously and relays information for operating the alarm and power cut-off.

Installed at Sudamdih and Moonidih coalmines of BCCL, this device has been functioning satisfactorily for the past two years A multi-point system—a modified version of the CMRS-developed singlepoint system—will be installed at Jamadoba coalmine of TISCO This version is capable of monitoring the methane concentration of several strategic underground locations simultaneously.

# Electronic tala generator

THE Madras Extension Centre of the Central Electronics Engineering Research Institute (CEERI), Pilani, has developed an electronic *tala* (time reference) generator which helps a (music) student get self-trained in *tala* Portable, compact (2 kg, 18×18×2 cm$^3$) and simple in operation, the device, which is fabricated with digital integrated circuits, gives a periodic and steady time reference based on which the student can practise four *talas* with adjustable speeds from 0 3s to 3.0s. It gives normal and double *kalai* nodes with variable tone It gives visual LED display in four colours. The instrument can also be used to provide basic *shruti*.

Designed under a sponsored project by P.E Sankaranarayanan of CEERI's Madras Extension Centre, the instrument has now been improved upon on suggestions from experts in music A prototype of the instrument has been handed over to the sponsor, Unique Electronics, Madras.

The generator (cost Rs. 970) won an award at the Small Scale Industrial Exhibition held at Madras in June, 1979.

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# Nitride-oxynitride bonded silicon carbide

THE Central Glass & Ceramic Research Institute (CGCRI), Calcutta, has developed nitride-oxynitride bonded silicon carbide

Silicon carbide refractories are widely used as bricks, tiles, crucibles, kiln furniture, muffles, recuperator tubes, etc , in metallurgical, ceramic and other industries. Such refractories, produced in India, have an alumino-silicate or alkaline earth silicate bond The high-temperature mechanical properties, thermal shock resistance and corrosion resistance of these refractories depend to a large extent on the nature of the binding material The nitride-oxynitride bonded silicon carbide are superior to other conventional silicon carbide refractories The properties of nitride-oxynitride bonded silicon carbide product developed at CGCRI are given in Table 1

Table 1

| | |
|---|---|
| Density | 2 3 g/cc (approx ) |
| Porosity | 23 29% |
| Modulus of rupture | 6 040 psi at room temp<br>7,273 psi at 1250°C<br>9,669 psi at 1350°C<br>10,523 psi at 1400°C |
| Thermal shock | No spalling upto 20 thermal cycles from 1250°C to room temp |
| Oxidation | Resistant to oxidation Total weight gain at 1350°C and in ambient atm of 4 7 mg/cm$^2$ |
| Thermal expansion | 3 7 × 10$^{-6}$/°C (0-1400 C) |
| Corrosion resistance | No attack by molten aluminium for 6 days at 800°C No attack by copper at 1150°C on submerged surface Necking at air metal interface after 24 hr |
| Fluoride bath | No attack upto 30 hr at 950°C in cryolite (85%)-AlF$_3$ (6%)-CaF$_2$ (6%)-Al$_2$O$_3$ (3%) bath Slow dissolution in blast furnace slag at 1450°C |

## TECHNOLOGY FOR VILLAGES

# Post-harvest technology

POST-harvest technology consists of a series of operations like handling, drying, storage, processing, packaging, transportation and distribution of agricultural products produced in the rural sector. The traditional practices suffer from several defects resulting in losses at various operational points which reduce the availability of food besides creating problems of safety and high cost. Special attention has been given by CSIR laboratories for solving these problems. The problem of improving the nutritional status of rural population is very much linked with proper storage of food grains and other edible products.

### Grain storage

Central Botanical Research Institute has developed large capacity grain silos (3 and 5 tonne capacity) for storage of food grains in rural areas. It had undertaken a survey on the grain storage requirements of villagers. The findings indicate that the demand for 3 tonne silos is about 31 per cent while that of 1 and 4 tonne silos was only 11 per cent. It was also found that conventional mud silos have serious drawbacks.

Structural Engineering Research Centre ferro-cement bins provide a scientific method for storage of grains. It involves minimum skill for fabrication and has maximum utility and serviceability. It can be fabricated to any desired size. The grain storage bins developed by SERC have been evaluated under different conditions of service in the villages and found useful. The technology is released through NRDC for commercial manufacture of ferro-cement storage bins.

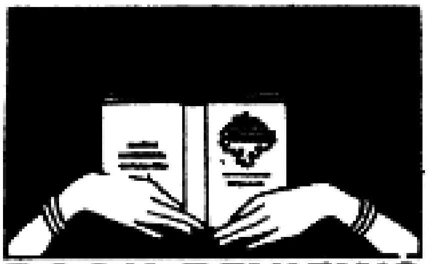
Cement Research Institute has developed storage structures to suit individual farmer as well as for bulk storage at the village level. Storage bins of 2 tonne capacity which are sufficient for an average farmer to store his annual requirement, cost only Rs. 250/- per unit. They are designed to protect grains from moisture and heat gradient within the grains, as also from rodents and pests attack. A prototype bin has been constructed within the CRI campus at Ballabhgarh. The efficiency of dampproofness of the bin is currently under study. For temporary bulk storage structure as an outdoor facility, hollow concrete blocks are proposed to be used for grain retaining walls because they are incombustible and also demountable, enabling rearrangement into structures of different sizes, as required.

Studies conducted at Indian Plywood Industries Research Institute have shown that it is possible to make grain storage bins of any capacity in the range of 0.1-60 tonnes or more from exterior grade plywood using nail glueing technique. Structurally, plywood bins have high strength and stiffness. Functionally, they can be made practically gas-tight to facilitate fumigation and to prevent moisture entry. Good thermal insulation properties of plywood reduce temperature fluctuations and consequent changes of moisture migration and condensation in stored grain. Properly designed and constructed, they are not damaged by rodents.

Indian Jute Industries Research Association is exploring the possibility of introducing mini-silo for storage of food grains in the countryside. A coating composition for jute fabrics in using bitumen and certain other ingredients for making the mini-silos is under investigations.

### Infestation control

Central Food Technological Research Institute CFTRI has carried out detailed studies on problems of storage under warehouse conditions; control of microflora in stored oilseeds and cakes; development of home-scale grain protection techniques—fumigant tablets; fumigation formulations and techniques; non-toxic insecticides; rodent control methods; field extension programmes on rural infestation control in Gujarat villages in collaboration with APSU; pesticide formulations for warehouse and food factories; integrated rodent control measures in selected villages and develop model centres to adopt suitable disinfestation techniques. Processes developed by CFTRI which have found application in the rural sector are Durofume formulations; Durofume process for storage of food grains; pest proofing emulsion for insect proofing of gunny bags, rat-burrow fumigation; rodent control technique, Durofume application kit, antifungal paste and pest-proofing machine. CFTRI techniques are being used by Food Corporation of India and traders for storage of food-grains in their godowns.



# BOOK REVIEWS

**VANISHING BIRDS—Their Natural History and Conservation** *by* Tim Halliday, *Penguin Books* (Available from: M/s Penguin Overseas Ltd., 706 Eros Apartment, 56 Nehru Place, New Delhi-110024.) Pp. 296, £ 2.50.

THE Dodo was a large, heavily-built bird that once inhabited the Indian Ocean island of Mauritius. It no longer lives there, nor anywhere else on earth, for it lost its battle for survival to man soon after he colonised the island centuries ago. Similar fate has befallen more than a hundred other bird species throughout the world, majority of these extinctions directly or indirectly caused by man.

But things are changing, albeit slowly. In recent years there has been a widespread and encouraging upsurge of interest in conservation and wildlife protection. Countless people around the world, both professional scientists and amateur enthusiasts, have taken up a fight against the indiscriminate and wanton destruction of natural habitats that has led to extermination of many a species in the past. In the present book, as the title shows, author Tim Halliday confines himself to birds, and attempts to analyse the causes of past extinctions. He then discusses some of the techniques that have been developed for the protection and preservation of the endangered bird species "with a view to assessing the prospects for the success of the conservation movement."

The number of living bird species in the world today is around 8600. Of these a few are flourishing, but many are declining in number and a few are on the verge of extinction. But why? To find an answer, the author looks at the way birds have evolved in order to identify what is it that makes some species particularly vulnerable to changes in their environment, natural or otherwise. Extinction, he says, is a phenomenon that depends not only on the degree of an individual's adaptations to its environment, but also on how the species population behaves. To understand the underlying causes of natural extinction one has to know "why some bird species are typically long-lived whereas others are short-lived."

Ecologists have now come up with the concept of what they call different "life-strategies" of species that make them more, or less, prone to extinction. There are the 'K-strategists'-typically large birds which are generally long-lived and lay only a few eggs at a time. They achieve a high reproductive output by breeding several times during their long lifetime. On the other hand are the 'r-strategists'—generally small birds which breed early in life, lay large clutches of eggs and tend to die young. Another important difference is in their feeding habits. The K-strategists tend to be extremely selective in the choice of the food they eat. The r-strategists, on the other hand, are able to feed on a wide variety of food, which gives them a better chance to adapt to changed environments.

In short, the K-strategists sacrifice short-term reproductive output for long-term survival whereas the r-strategists sacrifice long-term survival for a large short-term reproductive output. So it is the K-strategists that tend to be more vulnerable to extinction as compared with the r-strategists.

Halliday devotes a full chapter to three "case histories of extinction"—those of the Dodo of Mauritius, and the Solitaire of Rodriguez Islands in the Indian Ocean, the Great Auk of the North Atlantic and the Pink-headed Duck of the Indo-Gangetic Plain. These four birds became extinct at widely spaced intervals—the Dodo in 1681, the Solitaire around 1791, the great Auk in 1844 and the Pink-headed Duck around 1940. Together they illustrate how certain biological features of a species sometimes interact with environmental changes brought about by man leading to its extinction.

Other chapters deal with extinct and endangered birds of North America, New Zealand, Australia and Europe and birds on islands. The endangered birds of the Indian Subcontinent, viz., the Great Indian Bustard and the Western Tragopan of our North Eastern Hill forests get only passing mentions. The final chapter is devoted to conservation of endangered birds.

Apart from the lucid style of the text, the book's added attraction are the excellent drawings and paintings of birds all done by the author himself. Another important feature is the Appendix which lists the Latin names of all birds species (more than a hundred of them) mentioned in the text.

BIMAN BASU

**ASIMOV ON ASTRONOMY** *by* Isaac Asimov, *Coronet Books* (Available from : *Macmillan Co. of India*, 2/10, Ansari Road, Daryaganj, New Delhi-110002) Pp. 256, Rs. 15.20

ISAAC Asimov has been writing on scientific subjects for more than three decades. His writing output has been prodigious especially in the last two decades. Formerly a teacher of biochemistry at an American University he is today renowned as a human writing machine. Besides ar cles on various sciences he has to date written more than 200 books. A small part of these books is, however, collection of essays which he had written from time to time on various subjects in various magazines. In recent times the essays in these books have been again reshuffled to form new books. The book under review is one such. The essays on astronomical subjects, which have already appeared elsewhere, have been combined at one place so as to meet the increasing demand of books on this subject.

Doubtlessly, the book is an excellent compilation on astronomical topics. In his calculative and lucid style Asimov has discussed the subjects of interest to layman, namely, tides, asteriods, moons, planets, stars, comets, meteorites, galaxies and much more. With his usual dash of humor the essay read as if one is in a hall and listening to his lecture. Without much mathematics he is able to give everything in this sleek book, which is discussed in bulky texts on the subject. Some photos have also been included to catch reader's imagination. For astronomy-lovers and others, too, this low-priced book is an excellent buy.

DILIP M. SALWI

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### HUMAN AND SOCIAL BIOLOGY —EXAMINATION QUESTIONS AND OBJECTIVE TEST ITEMS

*by* L. Fairclough, *Hodder and Sloughton* (Available from *B.I. Publications*, 359, Dr. D.N. Road, Bombay-400001), Pp. 121, £ 1.85

THE book under review is a pool of readymade questions useful for teachers as well as students. The author, who is a senior biologist of Dean High School, Bolton, has written the book in accordance with the change in the present day examination systems which gives more emphasis on short and objective questions rather than lengthy and descriptive ones. At least in biological sciences, one prefers the former type to the latter one because of many reasons. The short questions test the candidate's memory and assess his or her understanding and interpretation capacity of the subject. Accordingly, various types of questions have been included in the book to test the knowledge and understanding of biological facts and theories, applications of the knowledge and the ability to evaluate and interpret biological information.

The book contains twelve chapters of varying length. Broadly, these chapters fell under two categories : the first category includes chapters on basic subject matter such as Cell Tissue, Organ and the Structure of the Body, Blood, etc., the other includes chapters like 'Food and Diet', 'Social Hygiene', etc. of applied value. The book, however, does not contain any text matter. Each chapter is composed of questions which are mainly of objective type. These questions could be grouped under heads like 'multiple choice', 'multiple completion', 'matching pair' and 'assertion/reason'. Each head is supported by sufficient number of questions. As biology needs diagrams, they are provided with questions wherever required. Surprisingly, no answers to these questions are provided. The language used in framing the questions is quite simple.

The author has also enlisted 'Instructions' for readers after 'Preface'. He feels—rather correctly—that candidates seldom read instructions carefully before they begin to write answers in examinations. These instructions provide guidelines pertinent to compulsory questions, diagrams, objective questions, mistakes, etc. The purpose of such instructions is to maximise efficiency in answering the questions.

The book is especially meant for the students of high school in the United Kingdom. It could, however, be used as a reference book by the students of ten plus two level.

R. K. RAGHUVANSHI

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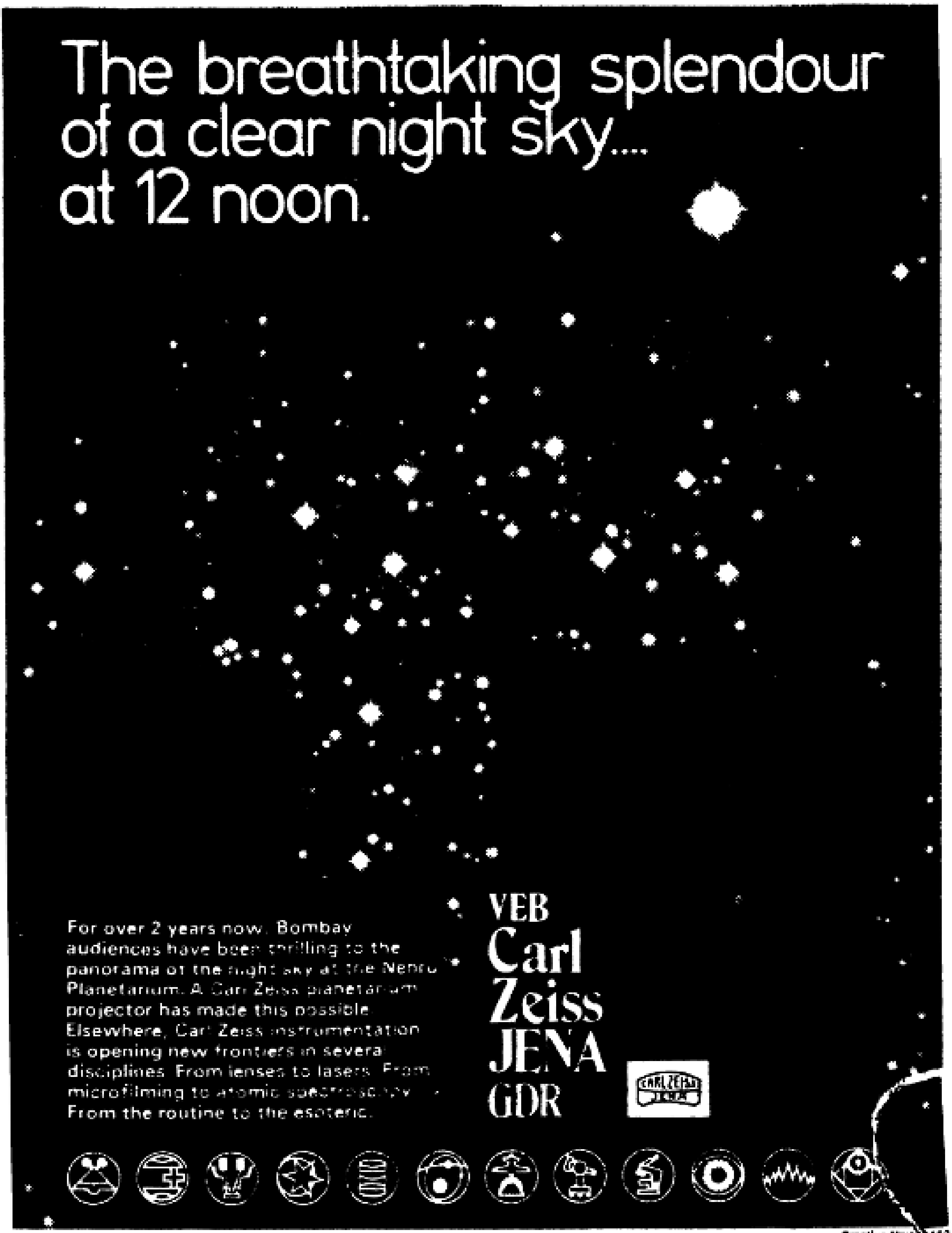
### Books Received

1. **WHERE THERE IS NO DOCTOR** *by* David Werner, *Macmillan Co. of India Ltd.* 2/10, Ansari Road, New Delhi-110002, Pp. 203 Price not stated
2. **ALCOHOL PROBLEMS**, Ed. *by* David Robinson, *Macmillan Co. of India Ltd.* (address as above), Pp. 254, £ 4.95
3. **BREAST FEEDING, the biological option** *by* G. J. Ebrahim, *Macmillan Co. of India Ltd.*, (address as above), Pp. 86 Rs. 12.00
4. **LABORATORY EXPERIMENTS IN DIGITAL SYSTEMS** *by* H. B. Dave, *Macmillan Co. of India* (address as above) Pp. 201, Rs. 35.00.
5. **SOLAR ENERGY, The Awakenking Science** *by* Daniel Behrman, *Macmillan Co. of India*, 2/10, Ansari Road, New Delhi-110002, Pp. 408, Rs. 35.00
6. **GENERAL ECOLOGY** *by* S. J. McNaughton and Larry L. Wolf *Macmillan*, London (Available from *Macmillan Co. of India*, address as above), Pp. 702, Price not stated
7. **PERICYCLIC REACTIONS, a mechanistic study** *by* S. M. Mukherji, *Macmillan Co. of India Ltd.* (address as above), Pp. 171, Rs. 58.00
8. **TEXT-BOOK OF PHYSICS (for class XII)** *by* N. K. Bajaj, R. K. Garg and S.K. Muthu, *Tata McGraw Hill Publishing Co. Ltd.* 12/4, Asaf Ali Road, New Delhi-110002, Pp. 515, Rs. 18.00



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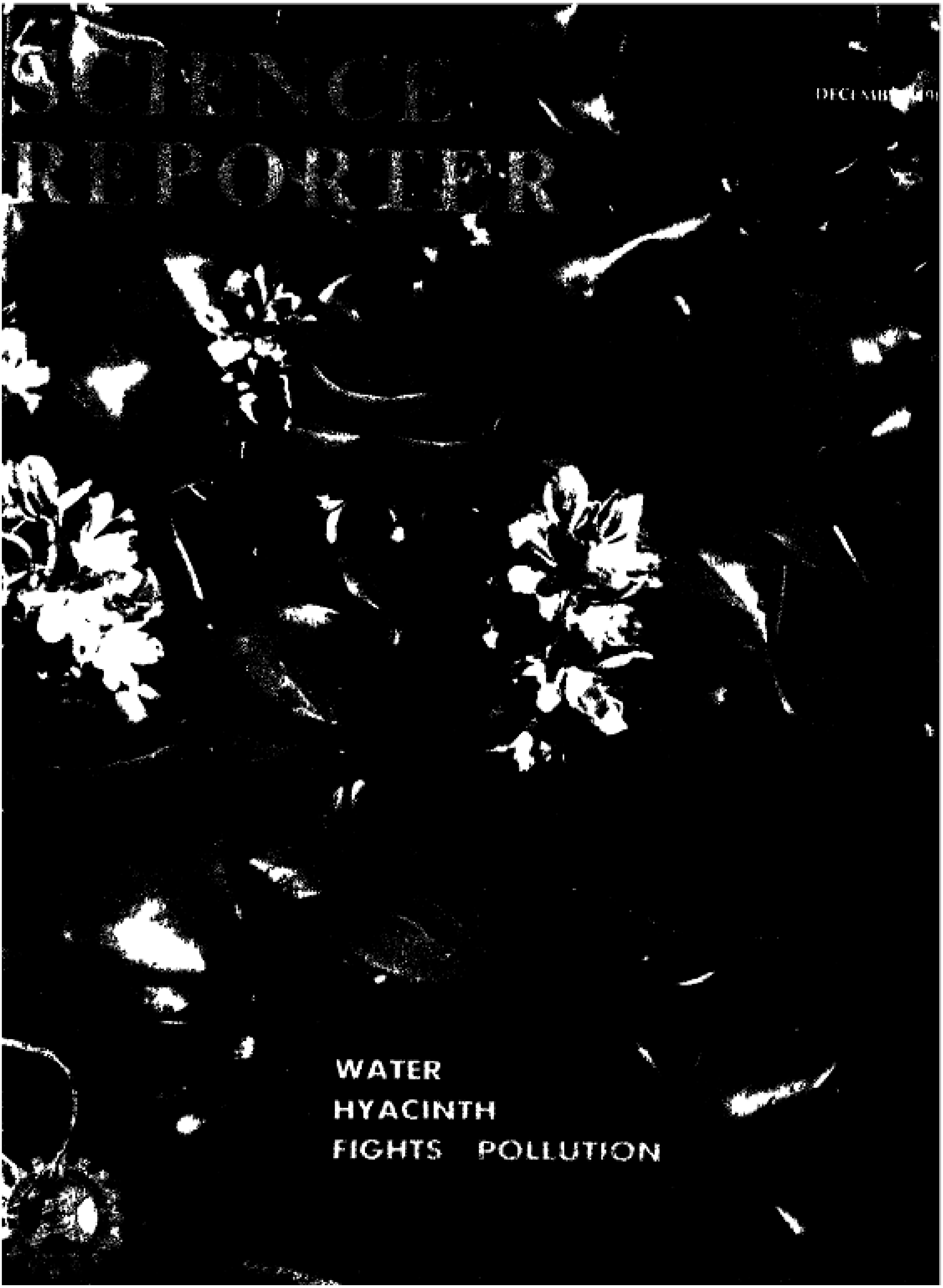

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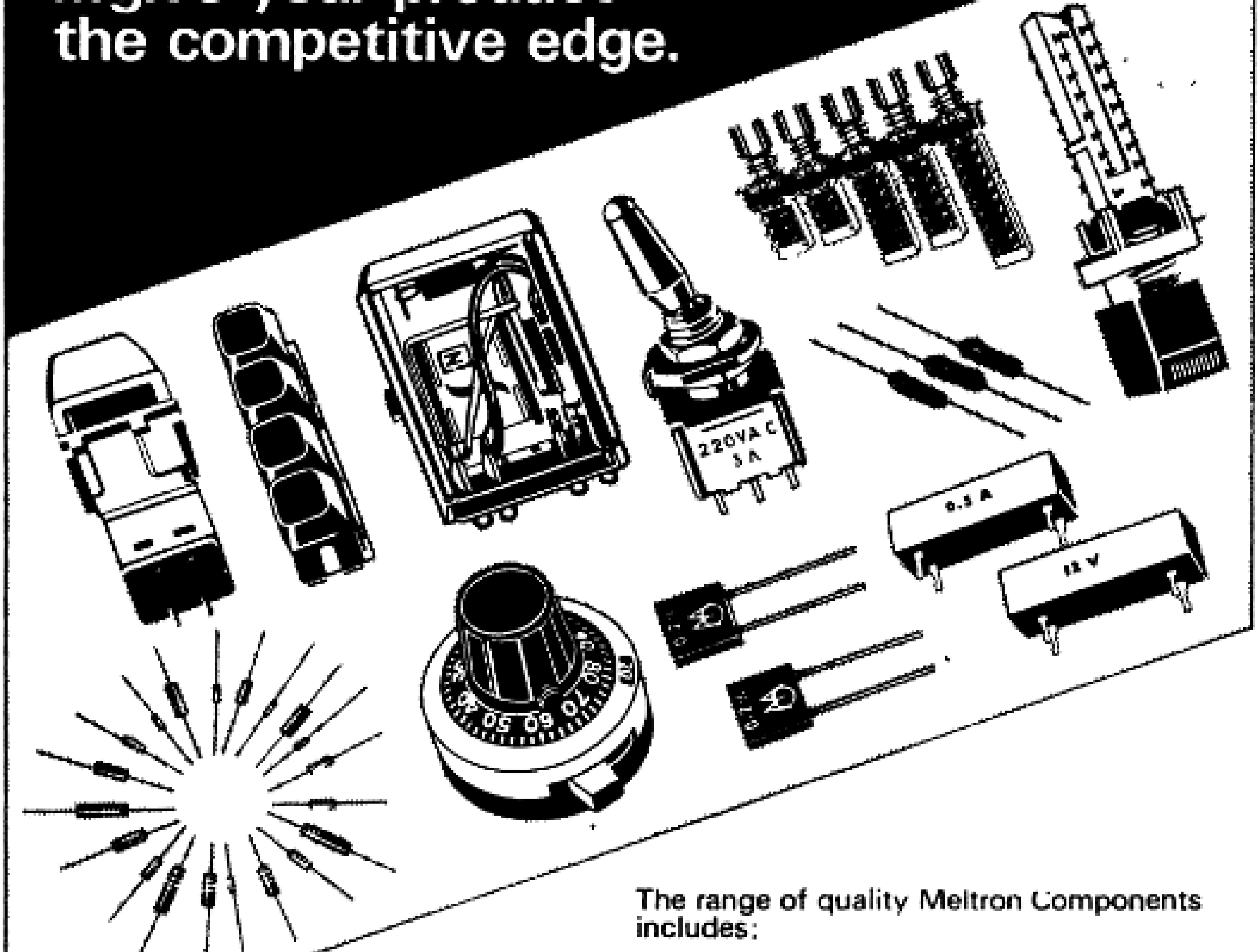

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# SCIENCE REPORTER

VOL. 17 DECEMBER 1980 NO. 12

*Cover transparency* Courtesy Prof H.Y. Mohan Ram, Department of Botany, Delhi University

752 LETTERS

755 PLANETS AND THEIR POSITIONS—JANUARY 1981

MAIN ARTICLES

756 Water hyacinth to fight water pollution — *Md Asrarul Haque, Sudhirendar Sharma*

764 RuBPcase-the wonder protein — *Y P Abrol*

770 The pigs — *B K Behura*

776 SCIENCE SPECTRUM

Solar pond—Greenhouses and greenhouse effect Urea inclusion complexes—Textiles can catch criminals—Wheat rusts *Parthenium hysterophorus*

788 NEWS & NOTES

Dr M K Chandrashekaran (interview) IPPTA symposium—International symposium on solar eclipse

790 MEDICAL NOTES

Garlic—an effective anti-microbial bulb Artificial pancreas

794 SCIENCE FOR THE YOUNG

Brain-teasers—They flavour our food—Ramanujan's number—Science quiz

799 FOR HER

Mother's milk versus cow's milk

801 SCIENCE IN INDUSTRY

Utilization of bagasse

802 TECHNOLOGY FOR VILLAGES

Rural industries

803 BOOK-REVIEWS

Messages From The Stars—Laboratory Manual In Molecular Genetics—Fresh Water Animals of India—Laboratory Experiments In Digital Systems

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# LETTERS

### Cigarette smoke

Sir, The article by Raj Mehrotra on **Hazards of Smoking** (*S.R.* Sept. 1980) has highlighted the health risks to which the smoker exposes himself. Recent studies have indicated (International Agency for Research on Cancer, Scientific Publication No. 19) the occurrence of nitrosamines in air polluted by tobacco smoke. Many nitroso compounds are strongly carcinogenic, so the environmental impact of smoking should not be ignored. While poisoning himself the cigarette smoker also creates a health hazard to others. The nonchalance of even the scientific community to this environmental hazard was best illustrated at a conference on "Air Pollution" held at a five-star hotel in Bombay recently with the hall full of tobacco smoke. The statutory warning of the hazard of smoking should be directed at both the smoker and non-smoker.

Incidentally, I read that the tars in smoke emanating from burning mosquito coils—which are made from pyrethrum marc—were found to be essentially similar to the tars in cigarette smoke (*Chemistry in Britain*, 1968, **4**, 472, Royal Institute of Chemistry, London). An allusion was made in the report to the presence of diphenylamine in the smoke. Has any serious attempt been made to evaluate the safety of mosquito coils, so popular with the Indian urban populace, particularly in view of the fact that one is exposed to the involuntary but prolonged inhalation of a chemical with potential carcinogenic propensity?

N. G. Wagle
*Chartered Chemist*
*Vileparle (East)*
*Bombay-400057*

### Smoking

Sir, Thank you for the informative article **Ladies beware of Lady nicotine** (*S.R.*, August 1980).

There are some facts about smoking that are of practical benefit. Once a person stops smoking, his chances of getting lung cancer are reduced. So that ten years after he stops smoking, the risk of his getting lung cancer is not much greater than for a life-long non-smoker.

A smoker is more likely to develop ischemic heart disease (e.g., heart attacks). If he stops smoking the risk is also reduced. Therefore smoking is a very important modifiable factor in the prevention of ischemic heart disease.

Viewed from the angle of causing disease, beedi smoking is the most harmful among all forms of smoking habits. Filtered cigarettes are safer than non-filtered cigarettes. Exhaling the tobacco smoke from the mouth without inhaling it deeply is less dangerous than taking it deeply into the lungs.

There is some evidence that cigarette smoking by mothers might cause congenital malformations in children and that women who smoke attain menopause earlier. However, these observations are not yet firmly established.

G. R. Sridhar
*House Surgeon*
*King George Hospital*
*Visakhapatnam-530002*

### Exercise

Sir, I read the article **Exercise—how and why?** (*S.R.*, Sept. 1980) by P. C. Gangwar. I would like to add a few points.

Massage is useful for those who are too weak to take sufficient exercise. It is a passive exercise. Its effects on circulation are seen in the relief from fatigue and weakness.

Yoga asanas give perfect physical health and resistance to diseases. The advantage of Yoga asanas is that they do not consume energy. It is gratifying to note that a number of institutions and organisations are nowadays propagating this type of physical culture.

Madhusudan Sharma
*N. H. Medical College*
*& Hospital*
*1, Cantt. Road*
*Lucknow-226001*

### Carnivorous plants

Sir, Thanks for publishing the interesting article **Plants that are meat eaters** by Md. S. Hoque in *S.R.*, July 1980. There is need for further researches on these plants because they may play an important part in human life. There are also unanswered questions about the digestive system of the plants, and their ability to assimilate animals and specially the predacious fungi because fungi are considered as most primitive plants.

Govind Prasad Agrawal
*Feroze Gandhi College*
*Rai Bareli-229001*

### Madagascar periwinkle

Sir, Re: **From garden to medicine chest—the Madagascar periwinkle** by G.N. Mohankumar and H. B. Lingiah (*S.R.*, June 1980, p. 404) The authors have given a good account of information regarding

*Cantharanthus roseus* G. Don (*Vinca rosia*). However they failed to mention the botanical family to which it belongs. For the readers interest I would like to add that it belongs to the familly Apocynacae.

P. VINDHIYA VARMAN
*Research Associate*
*Tamil Nadu Agricultural University*
*Cashew Research Station*
*Vriddhachalam 606001*
*Tamil Nadu*

### Cuttings

Sir, The article **Why do some cuttings fail to root?** (*S.R.*, July 1980) was informative. However, I would like to add some information regarding the cuttings taken from latex bearing plants like *Sapota*, jackfruit, rubber etc., which are very difficult to root. As soon as the shoot is cut, latex oozes out and the basal cut of the cutting may become plugged with the exudate. This forms a mechanical barrier to rooting of cuttings. To overcome this, a simple method is to wash the cut surface of the cutting with water repeatedly until no more latex exudes and then plant it. Another treatment employs dipping the base in dilute water suspension of charcoal and gum arabic which is allowed to dry on the base of the cutting. These treatments ensure better rooting in latex-bearing stem cuttings.

K. PURUSHOTHAM
*Horticulturist*
*Coffee Research Station*
*Chikmagalur Dist*
*Karnataka*

### II

Sir, Thanks for publishing **Why do some cuttings fail to root?** by M.K. Sadhu (*S.R.*, July 1980). The definition of a cutting in the article is, I think, a sweeping generalisation as it can include 'runners' and 'offsets' which are certainly not cuttings. Essential precondition for a part of the plant to be a cutting is that it must be detached from the parent plant before the missing organs are regenerated and in that way cuttings again differ from layerage. Mahlstede and Haber defined cuttings as any vegetative plant part which when detached from the parent is capable of regenerating a missing organ or organs. The location of the origin of root initials has also remained confused because the sentence 'Adventitious roots originate near vascular tissue' differs in meaning from that of 'root initials originating in the parenchyma cells of the vascular bundle' in the same para. Parenchyma of vascular bundles are, indeed, an integral part of vascular tissue and not 'near the tissue'. The three other rooting co-factors from *Hedera helix* according to the author, have not yet been characterised, nor have their mode of action determined. This is not wholly correct Co-factor 4 is a mixture of oxygenated terpenoid compounds and shows the highest activity in terms of stimulating root initiation and shows both qualitative and quantitative differences between easy-to-root juvenile and difficult-to-root mature form of *Hedera helix*.

A higher concentration of gibberellins was also observed in juvenile form (Hess, 1967). As regards mode of action of both the co-factors, isochlorogenic acid and oxygenated terpenoids, complete elucidation is still lacking. Some other substances as observed by the author in etiolated tissue reacting favourably with IBA have been explained by Hess (1968) as phenolic acids. These phenolic compounds that are normally utilized for lignin formation in green tissue are shunted into an alternate pathway favourable to root initiation in etiolated tissue which has been shown to lack lignin. This explanation gets support from observation of Fadl and Hartmann (1967) of a phenolic compound which is produced by buds on easy-to-root pear cultivar and forms a biologically active complex with exogenously applied IBA.

K. GHOSH CHOWDHURY
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### Meat eating plants

Sir, In connection with my article **Plants that are meat eaters** (*S.R.*, July, 1980), I would like to add a very important and conclusive information about uptake of nitrogen by carnivorous plants. Darwin's experiments with Sundew, *Drosera rotundifolia*, which he continued for two years, were so clear and direct that we are impressed with the elegance of his reasoning and doubtful that anything remains to be done for further investigation. It would have been really difficult to improve on Darwin's data and experiments of 100 years ago, without the discovery and easy availability of synthetic radioactive materials.

Almost all plants that carry on carnivorous activity, or "Carnivory" as it was called by Charles Darwin, are relatively primitive in their structure, especially in their root systems. Whether root development failed to occur in these plants or whether they developed this ability because their root systems could not supply enough nutrients is probably unanswerable. The question that strikes us is, "Is it possible to prove that a carnivorous plant actually digests insects it catches and assimilates the nitrogenous material from them?" This has been conclusively proved by an experiment done by Terry Ashley of the University of Lethbridge, Alberta, Canada and Joseph F. Gennaro, Jr., Professor of Biology, New York University, U.S.A. (*Natural History*, Dec.

1971, p. 80).

They worked with Sundew and fed it with radioactive phosphorus ($^{32}$P). By autoradiographic technique, it was possible to actually visualize distribution of radioactivity within the leaves and other plant organs.

For the experiment, fruit flies (*Drosophila melanogaster*) were cultured in covered dishes containing sugar solutions, yeast and to which radiophosphorus had been added. The insects grew at a fast rate. By the time several generations had passed, each insect was highly radioactive. One such radioactive fly was taken, and washed to remove surface radioactivity and placed at the end of a tentacle gland. After several hours or days, the fly was removed from the "fed" leaf. The plant was then dissected and radioactivity measured, both in a radiation counter and by placing the leaf against a sheet of photographic film until the radioactive material left an impression that could be developed by the usual means. In this way, it was possible to determine quantitatively the distribution in the plant of the radioactivity assimilated from the insect. The loss of radioactivity from the fly was very rapid at first and diminished only after a day or two. As might be expected, distribution within the plant of this assimilated nutrient material is first to the leaf on which the tentacle is situated; next the material moves rapidly through the plant until the greatest concentration is in the growth centre. That the tentacle's digestion and assimilation mechanism is an effective one becomes obvious when one realizes that all but 6.3 per cent of the original radioactivity in the fly was assimilated by the plant. This apparently indigestible remainder was probably radioactive phosphorus that had been incorporated into the exoskeleton of the insect.

The results of this experiment confirm that, by the practice of carnivory, these highly specialized plants have acquired for themselves a source of nitrogen for their own growth and development in an environment that is extremely poor in this element. By this means, they have been able to adapt themselves to an ecological niche that otherwise would not have been possible for them.

MD. S. HAQUE
*Research Officer*
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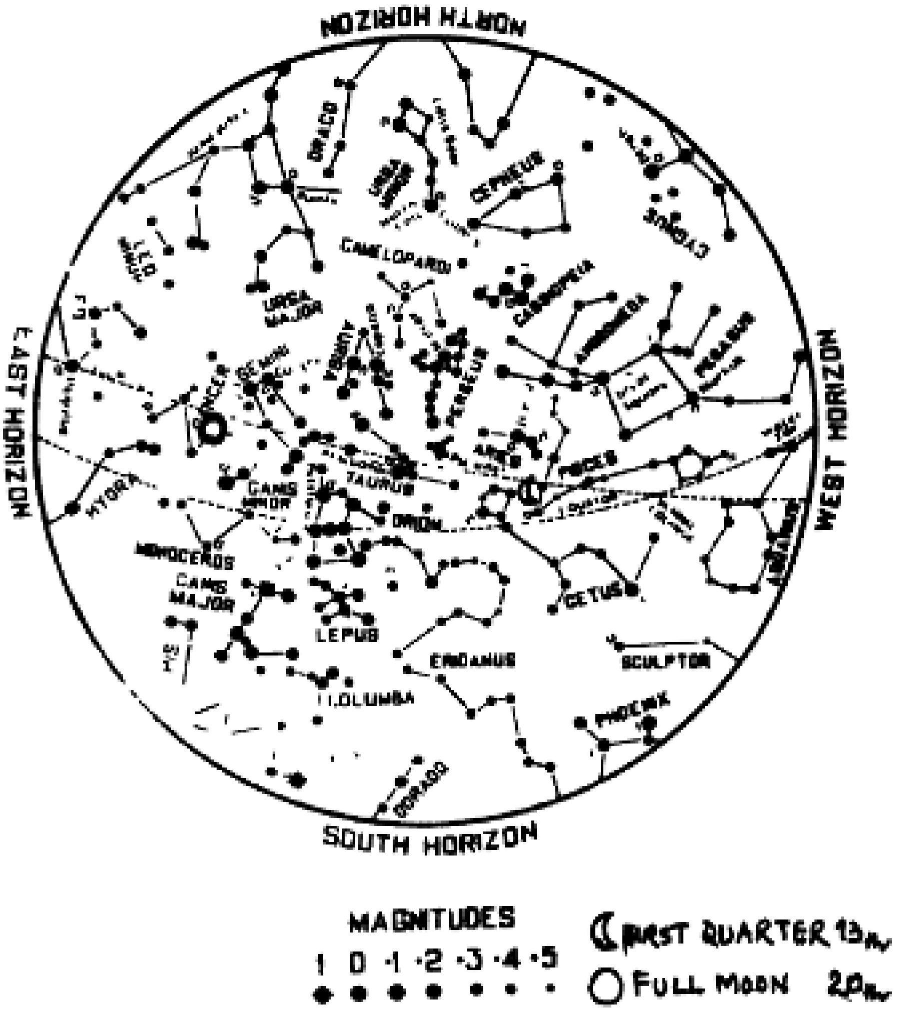
# Planets and their positions



**Planetary positions* for January 1981**

| *Date →*<br>*Planet* | *1st* | | *10th* | | *20th* | |
|---|---|---|---|---|---|---|
| | *RA* | *Dec* | *RA* | *Dec* | *RA* | *Dec* |
| Mercury | 18h 50m | 25.0°S | 19h 50m | 23.0°S | 21h 00m | 19.0°S |
| Venus | 17h 05m | 22.0°S | 17h 50m | 23.0°S | 18h 50m | 23.0°S |
| Mars | 20h 15m | 21.0°S | 20h 40m | 19.5°S | 21h 15m | 17.0°S |
| Jupiter | 12h 40m | 2.5°S | 12h 40m | 3.0°S | 12h 40m | 3.0°S |
| Saturn | 12h 40m | 1.5°S | 12h 40m | 1.5°S | 12h 40m | 1.5°S |

*Adapted from figures supplied by Positional Astronomy Centre, Calcutta.

### The moon

NEW Moon occurs on 6th at 12-54 p.m. and full moon on 20th at 1-09 p.m. I.S.T. The moon passes about three degrees north of Venus on 4th, four degrees north of Mercury on 6th, one and a half degrees north of Mars on 8th and about two degrees north of Saturn and three and a half degrees north of Jupiter in the night of 25th. The lunar crescent becomes first visible after the new moon day in the evening of 7th. The moon is at perigee or nearest to the earth on 15th and at apogee or farthest from it on 28th.

The earth is at perihelion or nearest to the sun on 2nd.

### The planets

**Mercury** (*Budha*) is too near the sun to be visible during the first half of the month. Thereafter, it reappears as an evening star and sets about an hour after sunset. It passes very close to the planet Mars on 24th It moves from Sagittarius (*Dhanus*) to Aquarius (*Kumbha*) through Capricorn (*Makara*). Its visual magnitude is about —0.8.

**Venus** (*Sukra*), a morning star, rises about an hour before sunrise during the month It moves from Scorpio (*Vrischika*) to Capricorn (*Makara*) through Sagittarius (*Dhanus*). Its visual magnitude is about —3.3.

**Mars** (*Mangala*), visible in the evening sky, sets about an hour after sunset during the month. At the end of the month, it is too near the sun to be visible It moves from Capricorn (*Makara*) to Aquarius (*Kumbha*) Its visual magnitude is about +1.4.

**Jupiter** (*Brihaspati*), visible in the morning sky, rises about an hour before midnight during the first half of the month and about two hours before it during the second half. It becomes retrograde on 25th. It is in Virgo (*Kanya*). Its visual magnitude is about —1.7.

**Saturn** (*Sani*), visible in the morning sky, rises about an hour before local midnight during the first half of the month and about two hours before it during the second half. It passes about a degree north of Jupiter on 14th. It becomes retrograde on 18th. It is in Virgo (*Kanya*). Its visual magnitude is about +1.0.

(*Source* · Director, Positional Astronomy Centre, India Meteorological Department, New Alipore, Calcutta-53)

MD. ASRARUL HAQUE
SUDHIRENDAR SHARMA

**Within the available means, water hyacinth, an otherwise pernicious weed in India, can be used to treat sewage**

# WATER HYACINTH

## fight water pollution

IT has been rightly said that man could not have survived if he was not provided with the pair of kidneys. Kidneys are the vital organs for the disposal of wastes produced in the body. Similar waste disposal systems are essential for every society, especially the urban ones. But unfortunately, most of our cities, not to talk of small towns and villages, do not have adequate backup of water supply and hygienic waste disposal systems.

### Magnitude of the problem

Even in the class I cities, which at present number 142, there is lack of adequate sewage collection and treatment system. These cities produce around 9000 million litres of sewage/day and only a third of this waste receives some form of treatment. As many as 72 of the class I cities with a total population of about 17 million have no facilities for sewerage and treatment of waste water. These unsewered cities include Vishakhapatnam, Srinagar, Dhanbad, Ranchi, Bhopal and Jabalpur. Sixtytwo of the class I cities have only partial sewerage and treatment system. Except Bangalore and Ahmedabad, all the state capitals come under this category.

Even in cities with sewerage systems the situation is not very encouraging. The treatment plants presently in function are highly inadequate.

---

S/Shri Md. Haque and Sharma are Research Scholars in School of Environment Sciences, Jawaharlal Nehru University, New Delhi-110067

Calcutta, which has a high population density as well as concentration of industries has no waste treatment plant. Bombay has a capacity to treat only 50% of its waste water although Delhi is a little advanced with 63% treatment capacity. In Madras only 25% of the waste water is being presently treated. Chandigarh, which is considered to be one of the best planned cities has a 100% sewerage system, but the treatment plants presently installed have the capacity to treat only 25% of the waste water. In total, the class I cities with a total population of 75.3 millions do not have the facility of sewerage for 49 million people. Sixtythree million people are so far totally deprived of any sewage treatment facility.

Due to inadeqate sewage disposal system, refuse invariably gets mixed with the open water resources leading to water pollution. Taking an average figure of 0.5 kg/capita/day of refuse generation, the quantity generated in large cities with a population of one million and above will be more than 500 tonnes/day. Similarly smaller towns and cities would produce refuse in proportion to their population.

The main component of water pollutants coming from residential areas are organic matter, excess nitrogen, excess phosphate, suspended solids, etc. The industrial effluents bring, in addition to these substances, heavy metals, phenols, oils, etc. At present, there are more than 5000 major and medium industries and only 1000 of them have some kind of waste treatment facility. The rest all allow their waste to mix with water bodies completely untreated. All these substances progressively collect in natural water systems, first in the surface water and subsequently in the groundwater too. As the surface water and groundwater are the only source of water for drinking and irrigation, the increasing concentration of these pollutants is a major cause of concern.

Chemical pollutants harm the water bodies in many ways. Some of the organic compounds act directly as toxins and carcinogens, while others increase the BOD (biological oxygen demand) which lowers the content of dissolved oxygen in water causing suffocation and death of aquatic flora and fauna. Still others may add objectionable taste and odour to drinking water. They

**Table 1. The state of sewage disposal in some major cities of India**

| | *City* | *Approx. present population* | *Present practice of sewage disposal* |
|---|---|---|---|
| 1 | Greater Calcutta | 7,500,000 | Only a part of the city is sewered, with primary treatment provided. Part is used for farming, the balance going to the river in an untreated condition. |
| 2. | Greater Bombay | 5,500,000 | Only 10% of the city sewage is treated, partly with secondary treatment. The balance goes untreated to the sea, and an odour problem exists in some areas. |
| 3. | Delhi | 3,600,000 | Three modern plants with primary treatment for 98 mgd and secondary treatment for 32 mgd. |
| 4. | Madras | 1,800,000 | Part of sewage used for irrigation and part goes direct to the sea. |
| 5. | Kanpur | 1,500,000 | No sewage treatment plant. Part of 6 mgd for irrigation. |
| 6. | Hyderabad | 1,300,000 | Screening and grit removal followed by irrigation. |
| 7. | Bangalore | 1,250,000 | New sewage treatment plant. |
| 8. | Ahmedabad | 1,250,000 | Two modern treatment plants. |
| 9. | Pune | 750,000 | |
| 10. | Nagpur | 700,000 | |
| 11. | Lucknow | 675,000 | |
| 12. | Agra | 550,000 | No treatment. Pumped for farming. |
| 13. | Varanasi | 450,000 | |
| 14. | Madurai | 450,000 | |
| 15. | Allahabad | 450,000 | |
| 16. | Amritsar | 400,000 | |
| 17. | Indore | 400,000 | |
| 18. | Jaipur | 400,000 | Secondary treatment plants. |
| 19. | Sholapur | 250,000 | Effluents used for farming |
| 20. | Patna | 275,000 | |

may be less harmful but are certainly undesirable.

Inorganic compounds have many adverse effects on human population, animals and plants. Toxic heavy metals can induce a variety of effects once they enter the living system. For example, cadmium and lead, besides being carcinogenic have been linked to kidney troubles, hypetrension and other cardio-vascular disorders. Chromium is toxic as well as carcinogenic. Silver can cause blue-grey discoloration of the skin and may become toxic, if it accumulates in body beyond a certain concentration.

Water pollution can cause indirect health hazards also by way of various pathogenic diseases such as malaria, filariasis, cholera etc. About 50% of the diseases commonly encountered in India are water borne. An estimated 80% of children in our villages suffer from parasitic helminthic diseases caused by contamination of open waters with nightsoil. This is not unusual because only 5% of the population in villages receive piped water supply and the rest have to depend on untreated surface or groundwaters.

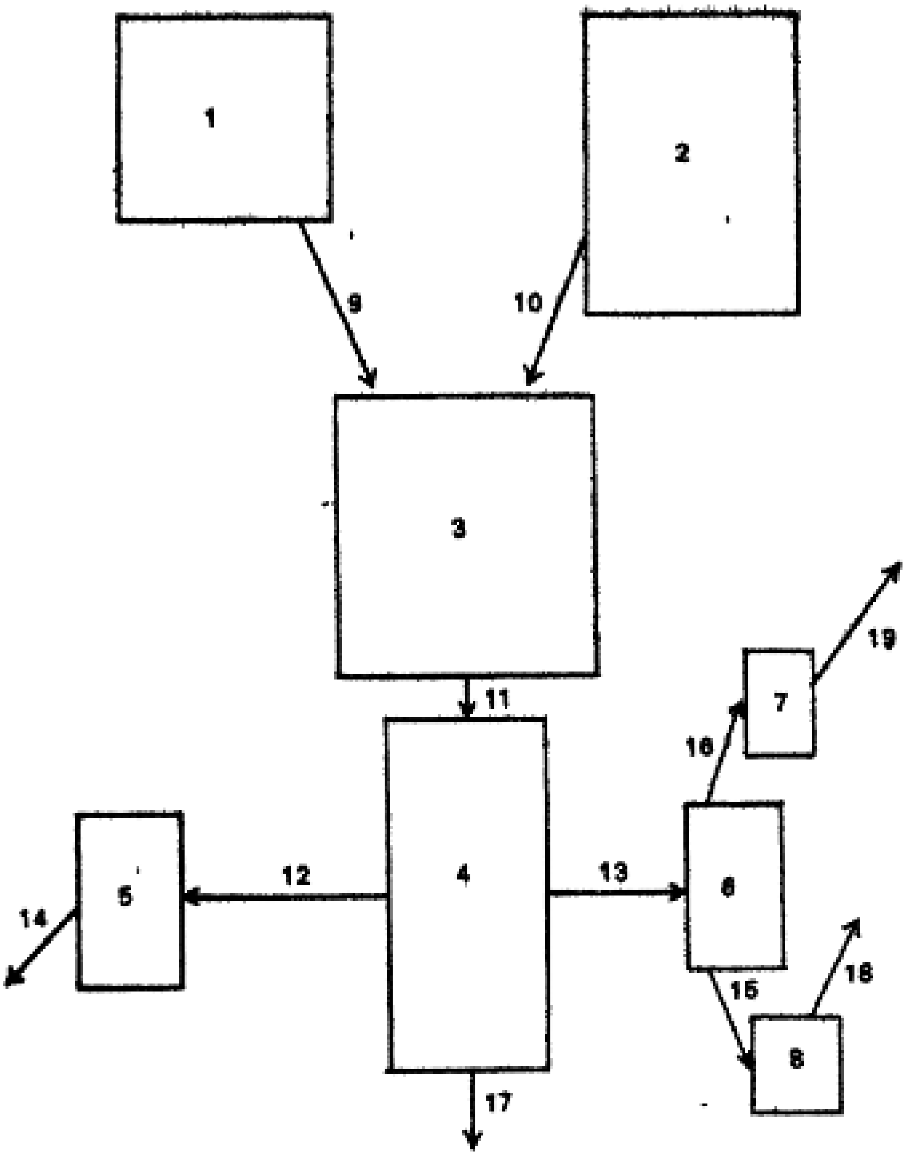


**Fig. 1. A model system for effluent treatment using water hyacinth and subsequent utilization of harvested hyacinth plants; (1) Residential area, (2) Industrial area, (3) Primary lagoon, (4) Hyacinth filteration pond, (5) Animal feed processing unit, (6) Biogas generation unit, (7) Biogas storage system, (8) Fertilizer processing unit, (9) Household effluent, (10) Industrial effluent, (11) Effluent free from solids, (12) and (13) Harvested hyacinth, (14) Animal feed, (15) To fertilizer unit, (16) Biogas, (17) To river, (18) Fertilizer, and (19) To residential areas and industrial areas**

### Economics of the problem

From the above account, it becomes amply clear that total sewerage system and subsequently complete treatment of the sewage is not a luxury but a necessity. However, the basic question is: How to achieve this? According to the Central Board for the Prevention and Control of Water Pollution (CBPCWP) an expenditure of Rs. 1170 crores would be required for provision of sewerage and sewage treatment facilities in the class I cities alone. If we include other cities, towns and rural population the amount needed would be several times more. The Draft Sixth Plan indicates a provision of only Rs. 805 crores for urban water supply and sewerage. The bulk of this would be spent on water supply schemes as in the earlier plans leaving a meagre amount for developing sewerage and sewage treatment facilities. This may mean that we will continue to add pollutants to our water bodies till they become dangerously unhygienic for drinking and agricultural uses.

So we are left with a dilemma; on the one hand we cannot underestimate the necessity of safe drinking and irrigation water, while on the other the quantum of money needed for expanding and creating such facilities with the present system is prohibitively high. The only way out would be in terms of a viable economic alternative, which could achieve the target in a low budget.

### Water hyacinth

There is a water weed commonly known as water hyacinth (*Eichornea*

**Table 2. Effect of treating sewage effluent in a 0.28 ha lagoon with 6.8 million litres and flow rate varying from 4,37,000 to 18,93,000 litres/day**

| | *Total Suspended (TSS)* | *Solids mg/Litre* | *Biochemical mg/Litre* | *Oxygen Demand (BOD)* |
|---|---|---|---|---|
| | *Inflow* | *Outflow* | *Inflow* | *Outflow* |
| *Baseline data prior to addition of water hyacinth (May)* | 31 | 49 | 22 | 32 |
| *Data after addition of water hyacinth* | | | | |
| July | 33 | 7 | 27 | 11 |
| August | 35 | 13 | 26 | 5 |
| September | 43 | 6 | 22 | 7 |
| October | 48 | 9 | 25 | 7 |
| November | 50 | 10 | 29 | 15 |
| December | 52 | 24 | 32 | 24 |
| January | 47 | 16 | 57 | 24 |
| February | 67 | 25 | 135 | 30 |
| March | 50 | 25 | 70 | 28 |

**Table 3 Reduction of organic nutrient and heavy metal pollutants from effluent in a 0.2 ha canal covered with water hyacinth (mg/litre)**

| | *Organic carbon* | *BOD* | *Total dissolved solids* | *Nitrogen* | *Phosphorus* | *Metals* |
|---|---|---|---|---|---|---|
| Inflow | 75 | 33 | 380 | 2.36 | 0.48 | 0.99 |
| Outflow | 13 | 3.6 | 212 | 0.43 | 0.08 | 0.001 |

**Table 4 Analysis of water hyacinth before (A) and after exposure to waste containing metals for six weeks (B)** (*Values in ppm dry weight*)

| *Metal* | *Leaves* | | *Stems* | | *Roots* | |
|---|---|---|---|---|---|---|
| | *A* | *B* | *A* | *B* | *A* | *B* |
| Copper | 17.5 | 32 | 10.9 | 48 | 24.0 | 594 |
| Lead | 8.4 | 33 | 2.1 | 45 | 40.0 | 297 |
| Silver | 0.8 | 9 | 0.1 | 4 | 36.0 | 113 |
| Cadmium | 0.1 | 2 | 0.1 | 10 | 0.1 | 164 |
| Chromium | 0.1 | 4 | 0.1 | 12 | 0.1 | 286 |

*crassipes* belonging to the family Pontedariaceae). So far, this plant has been considered to be one of the worst weeds in many countries. A native of South America, it has now almost a global distribution. In India, there are 10 widely spread noxious weeds, and water hyacinth tops the list. It was introduced in India from Brazil in 1896 and within a short span of 90 years it has established itself throughout the country.

Water hyacinth interferes with agriculture, fishery, drainage, irrigation, water sports, etc. In West Bengal alone, 12000 hectares of land is rendered unfit for cultivation during summer season due to this weed. In rainy season, the problem becomes even greater. The economic loss due to this weed in this State alone has been estimated at about 110 million rupees per year. In Bihar this weed is equally common particularly in North Bihar. In this area it is difficult to find any pond, ditch or other water body which is free from hyacinth. During rainy season even the paddy fields are infested badly thus causing tremendous loss to fisheries and agriculture. The situation in U.P., Assam, Himachal Pradesh and Punjab is equally bad. Apart from these states this weed has been generally reported from Nagaland, Tamil Nadu, Tripura, Andaman and Nicobar, Lakshadweep, Andhra Pradesh, Karnataka, etc. In 1974 the weed was reported to be causing concern in 98 districts out of 246 districts surveyed in the country.

Water hyacinth has a tremendous capacity to grow and regenerate. Even a small piece of the plant can produce a full crop within a short span of time and a crop of water hyacinth can double itself within eight to ten days. Another important aspect of the physiology of water hyacinth is that it can absorb at remarkably high rate, minerals, nutrients, heavy metals, organic substances, etc. Under normal conditions this is considered a negative aspect of this weed because it reduces the nutrient contents of water rendering them weak for irrigation. But this property can be utilised to remove the same substances when present as pollutants from domestic or industrial sources.

In conventional sewage treatment systems only a part of the pollutants are removed, rest remain with the effluent. The present process of treatment normally does not remove the heavy metals and the various

Fig. 2 Hyacinth plants growing in an experimental effluent treatment pond

dissolved substances. Heavy metals can be removed by chemical precipitation, electro-deposition, solvent extraction, ultra-filtration, ion-exchange and-activated carbon-absorption. However, all these methods are highly expensive. With the growing needs of industrialization, the quantities of heavy metals reaching our natural water resources will be even higher.

Recent findings have shown that if water hyacinth is permitted to grow on effluents coming from domestic or industrial sources, it can absorb most of the harmful substances considered to be pollutants. For this purpose, there is no need for any chemical treatment. The effluents are just fed into reservoirs big enough to allow them to remain in contact with water hyacinth for sufficient time. Experimentally, it has been found that in a lagoon of 0.5 hectare containing dense growth of water hyacinth, with sewage retention time of two weeks the daily wastes of 1000 people can be treated. Such a treatment can reduce the pollutants by 75% to 90% (Table 2). Similarly, bigger lagoons can be created with water hyacinth where wastes from [illegible]

Industrial effluents are almost impossible to treat chemically to make them acceptable for drinking or agricultural purposes. Removal of the heavy metals is very difficult. Chemical processes which can do this (as listed above) are highly expensive to install and maintain. Added to this is their low efficiency. Water hyacinth can be utilized as a viable alternative for treatment of industrial effluents also. The US National Aeronautics and Space Administration has already created an experimental water hyacinth chemical waste filteration system for treating the effluents from their photographic labs at NSTL Station, Mississippi. The characteristics of the feedwater and effluent from the filteration system are given in Table 3. The treatment plant consists basically of a zig-zag canal (Fig. 3) in which water hyacinth is grown. During passage through the hyacinth-filled canals most of the pollutants including metals are removed from the effluent.

The most remarkable feature of water hyacinth is its capacity to accumulate heavy metals (Table 4). Over a six week period the plant can accumulate certain heavy metals to concentrations of several hundred times the initial levels. As the metals are extracted from the effluents, it causes significant cleaning of the effluent (Table 3). Water hyacinth can remove even radioactive metals from effluents which is very difficult otherwise. The pH of effluent after treatment has been found to be between 6.8 and 7.8 which is an ideal range for fresh water. Further, there is no algal bloom and the BOD and COD are generally brought down to the level at which the effluent can be allowed to mix with fresh water without causing any pollution.

The existing water treatment plants can also be improved with the help of water hyacinth. Table

Table 5 Comparative per cent reductions of TSS and BOD

| *Month* | *Percent reduction* | | | |
|---|---|---|---|---|
| | *TSS* | | *BOD* | |
| | *Without water hyacinth* | *With water hyacinth* | *Without water hyacinth* | *With water hyacinth* |
| May | 48 | 92 | 89 | 97 |
| June | —27 | 79 | 54 | 96 |
| July | —28 | 88 | 72 | 96 |
| August | 2 | 94 | 72 | 84 |
| September | 46 | 91 | 86 | 96 |

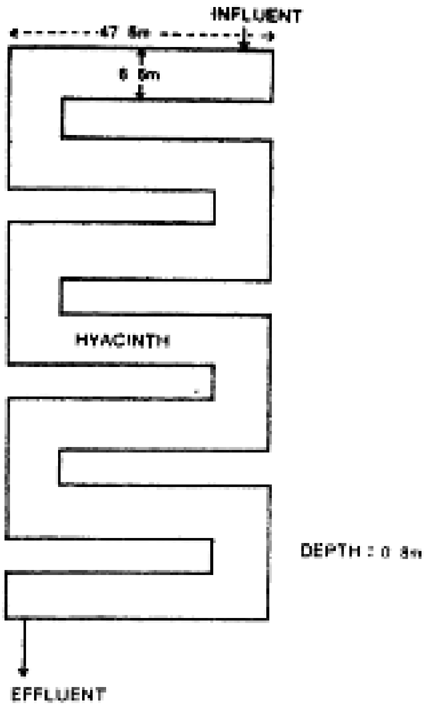


Fig. 3

5 lists data for an existing treatment lagoon where hyacinth has been added. The purifying capacity of the lagoon could be increased several hundred times simply by introduction of water hyacinth. Nitrogen content was reduced by 73%, total phosphorus by 63% and total organic carbon by 69%. The cost involved was very little. If the same was to be done by chemical means the cost of treatment would have been about seventy times higher!

In India, water hyacinth can grow very well due to the prevalent high temperature all round the year and hence can be utilized to the maximum. It would not require any imported technology. Only we have to create lagoons as described above, big enough to hold the effluents for required retention time. The lagoon has to be seeded with water hyacinth and once the crop is there, effluents from domestic or industrial sources are simply to be pumped at one end and the clean water collected from the other. The cost involved will not be very high and every industry or human settlement can afford such a system. The system can be made even more economical by properly utilising the harvested hyacinth. Some planning is however essential.

## Harvest and utilization of hyacinth plants

One hyacinth crop can perform its job for a limited period only, hence regular harvesting of the old plants is essential so that new plants can take their place. The hyacinth crop so harvested may create problems if left as such. On decomposition (uncontrolled) the nutrients and metals locked in the body of these plants would be released and may again reach the water systems. Hence, they should be utilized in such a way that such problems do not arise.

**Table 6. Chemical composition of water hyacinth grown on normal sewage**

| *Element* | *Per cent dry weight* |
|---|---|
| Carbon | 32-35 |
| Hydrogen | 5.4-5.8 |
| Nitrogen | 2.8-3.5 |
| Potassium | 2.0-3.5 |
| Sodium | 1.5-2.5 |
| Calcium | 0.6-1.3 |
| Phosphorus | 0.4-1.0 |
| Sulfur | 0.3-0.4 |
| Magnesium | 0.2-0.3 |
| Iron | 0.03-0.05 |
| Zinc | 0.005-0.05 |
| Manganese | 0.005-0.008 |

The hyacinth plant contain quite a high proportion of proteins and minerals and can be used as animal feed supplement. The nutritional value of water hyacinth compares favourably with that of Bermuda grass (*Cynodon dactylon*). When grown with normal sewage (not containing toxic substances) the hyacinth plants contain adequate quantities of all essential elements which are required for animal feed (Table 6). The University of Florida (USA) has successfully used hyacinth for this purpose. NASA has also used it for mixing with conventional diet (upto 20%), of beef cattle and other domestic animals.

Water hyacinth meal is a good source of organic fertiliser and soil conditioner. It contains adequate proportion of nitrogen and minerals. The average C : N ratio of hyacinth is 23 : 1 which compares favourably with that of legumes (20 : 1 to 30 : 1) and is better than that of several other straws, with C : N of 90 : 1. However, here also we have to be cautious enough not to use hyacinth,

**Table 7 Biogas and methane production under different conditions**

| *Experiment* | *Per cent methane in total biogas* | *ml biogas per gram wet weight* | *ml methane per gram wet weight* |
|---|---|---|---|
| 1 | 61.5 | 17.9 | 11.0 |
| 2 | 57.2 | 11.1 | 6.4 |
| 3 | 61.1 | 12.9 | 7.9 |
| 4 | 69.2 | 12.9 | 8.9 |
| 5 | 91.1 | 12.4 | 11.3 |

1. Wet mass = 300 g chopped
   Temperature ; 25±5°C
   water = 800 ml
2. Wet mass = 754 g
   chopped
   Temperature : 25±5°C
   Water = 800 ml
3. Wet mass = 800 g
   blended into slurry
   Temperature : 25±5°C
   Water = 800 ml
4. Wet mass = 500 g
   chopped
   Temperature : 36°C
   Water = 350 ml
5. Wet mass = 500 g
   chopped
   Temperature ; 36°C
   Water = 350 ml
   Metals : Ni = 9.95
   and Cd = 12.66 (mg/kg wet weight).

plants containing toxic substances for this purpose as the soil will get polluted.

### Biogas production

Water hyacinth can be successfully used for production of biogas which is now considered to be a viable alternative to petroleum and natural gases. We are already aware of biogas in the form of 'Gobar gas'. The process for 'hyacinth gas' is almost same and the biogas produced from hyacinth contains 60%-80% of methane. 374 litres of biogas can be produced from one kg of dried water hyacinth and one hectare can produce 600 kg of dry plant material per day, which can produce 2,29,400 litres of biogas/hectare/day The fuel value of this biogas has been calculated to be 21,000 BTU (British Thermal Unit) per cubic metre which is satisfactory enough At high temperatures, the methane content in the gas produced by water hyacinth is still higher (Table 7)

When the hyacinth plant contains heavy metals such a nickel and cadmium, the methane content in the goes biogas upto 91 1% (Table 7) With metal contaminated plants, the rate or production of gas is also faster Hence for biogas production hyacinth harvested from lagoons receiving industrial wastes will not have any disadvantage. The Sudanese government is already experimenting with small-scale units for producing biogas from hyacinth harvested from the White Nile.

### Recovery of metals

In case the proportion of metals (particularly the precious ones) is high in the hyacinth plants from lagoons, the digested product coming out of the biogas plant may be stored in especially designed pits so as to check any infilteration to the ground water The metals would continue accumulating in the pits. After some time it would be economically viable to extract the metals from the digested hyacinth In case the hyacinth is contaminated with such toxic substances which are of no use, the hyacinth plants should be disposed underground in such a manner that neither the plant matter gets exposed in years to come nor it pollutes the underground water table

### Further reading

1 Varshney, C K and Rzoska, J Junk, W (Eds.), *Aquatic weeds in South East Asia* B V Publishers, The Hague (1976)

2. *Making aquatic weeds useful: Some perspectives for Developing countries*, National Academy of Sciences, Washington DC (1976).

3. Mohanrao, G J. (1973), *Indian Journal of Environmental Health*, 15(3), pp. 223-225.

4. Sheffield, C.W , *Hyacinth Control Journal*, 4,5 (1975)

5 Wolverton, B.C., *Water hyacinths for upgrading sewage lagoons to meet advanced waste-water treatment standards, Part II*, NASA Technical Memorandum TM-X-72730, Washington D C (1976)

6. Wolverton, B C and McDonald, R C , Water hyacinth sorption rate of lead, mercury and cadmium , *NASA/ERL Report No 170* , Washington D.C. (1978)

7 Wolverton B C and McDonald, R C , Water hyacinth productivity and harvesting studies, *NASA/ERL Report No 171* Washington DC (1978)

8 Wolverton B C and McDonald, R C , Nutritional composition of water hyacinth grown on domestic sewage, *NASA/ERL Report No 173*, Washington D.C. (1978)

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## ANSWERS

### Brainteasers

(1) When the sides of the big square are extended then the small square is divided into four, equal areas as O is the centre of the small square (see Fig. 2). So the area of shaded portion is equal to area of the small square divided by four. $\frac{6 \times 6}{4}$ =9 sq. cms. The fact that AC is trisected is just to confuse the reader.

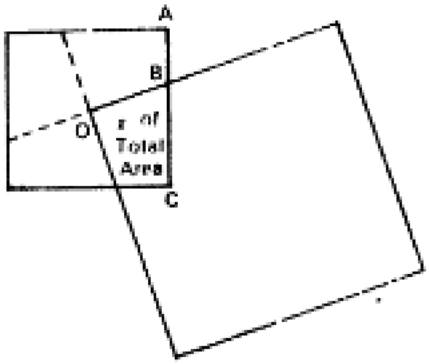

Fig. 2

(2) In this problem Mr. B has three alternatives : (a) Red-Red (b) Green-Green, (c) Red-Green He assumes that if the stamps on his forehead are Red-Red, then, after all have answered Mr. A would reason as follows ; "I cannot have Red-Red because Mr. C would have seen four Red stamps and answered. Mr C cannot have green-green stamps since Mr. B would see four green stamps and know that he has Red-Red on his forehead and answer Therefore I must have Red-Green stamps"

But when Mr. A could not answer in the second round of questioning then Mr. B ruled out the possibility of Red-Red on his forehead. Similarly he rules out the possibility of Green-Green., and he was only left with one alternative, i.e., Red-Green which was the correct answer.

### Science quiz

1. (a), 2. (a), 3. (b), 4. (b), 5. (c). 6 (a), 7 (c), 8. (b), 9. (a), 10. (c).

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Y P ABROL

# *RuBP case* THE WONDER PROTEIN

**This soluble leaf protein is not only the most abundant in nature, it has outstanding nutritional value as well.**

ALL photosynthetic organisms assimilate carbon dioxide to form sugars by the action of the enzyme Ribulose 1, 5-bisphosphate carboxylase (RuBP *case*) The earliest discovery of RuBP *case* was made in 1947 by S G Wildman and J Bonner (Univ of California, Los Angeles) who observed a major protein in the green leaves and called it Fraction I Protein due to its electrophoretic homogeneity In 1956, A Weisbach *et al* (*J Biol Chem*, **218**,795) purified from spinach an enzyme which formed phosphoglyceric acid (PGA) from ribulose 1, 5-bisphosphate and carbon dioxide The physical properties of this enzyme, including sedimentation coefficients, were identical to fraction I protein of Wildman RuBP *case* often comprises 50%, 65% soluble leaf protein, which is the reason for it being referred to as the most abundant protein in nature It is also called by another name, carboxydismutase

## Structure

In 1965, Haselkorn *et al* observed Chinese cabbage RuBP *case* having complex quaternary structure, by using electron microscopy techniques He proposed that the enzyme was a cube of about 120 angstroms having 24 subunits

Later, the enzymes from spinach and tobacco were most rigorously characterised The enzyme from spinach has a molecular weight of 5,57,000 and is composed of non-identical subunits. In 1967, A Rutner demonstrated that the enzyme is composed of two types of subunits which differ greatly in size and amino acid composition. T S Baker *et al* (1975) by combining the information from X-ray crystallography, electron microscopy, optical diffraction and crystal density, proposed that the structure of crystalline tobacco RuBP *case* is 8 large (LS) and 8 small (SS) subunits (molecular weight of LS—51000 to 58000 and that of SS 12000 to 18000) The molecule is arranged as a two-layered structure, each layer having 4 large and 4 small spherical masses whose volumes are proportional to large and small subunit masses (Fig 1)

## Synthesis

The most detailed understanding of the interaction between the nuclear genome and the one located in another organelle concerns the synthesis of RuBP *case* in plants The diagram summarizes the current model for the synthesis of RuBP *case* in green plants All the steps have been demonstrated in cell-free extracts with the exception of the transcription of the small subunit gene The chloroplast DNA codes for the large subunit and nuclear DNA—for small subunit. Single 2000 to 2200 base-pair segment of chloroplast DNA contains information for large subunit (L Bogorad, 1979), *Genetic Engineering*, Vol 1, p 181-203) The precursor of the small subunit is synthesized to completion in the cytoplasm and then transported into the chloroplast The precursor, like most animal secretory proteins, has an additional sequence at its N-terminus which is removed by a processing enzyme located in the stromal portion of the chloroplast (Smith, S M, Ellis, R J, 1979, *Nature* **278**, 662) The function of the extra sequence is not known It may be involved in recognizing specific receptors in the chloroplast envelope, or its removal may trigger a conformational change resulting in transport across the envelope membranes. The assembly of organellar protein occurs inside the chloroplast

Polypeptides synthesized in cell-free systems programmed with pea leaf cytoplasmic mRNA have been shown to enter the isolated chloroplasts by R J Ellis, by a post-translational mechanism, **the elucidation of which is currently one of the most interesting areas of research** (Ellis, R J, BBA 693:185, 1977; Highfield.

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P.E., Ellis, R.J., *Nature*, **271**:420, 1978) (Fig. 2).

### Mechanism of action

RuBP *case* catalyzes a dual reaction: (a) carboxylation of RuBP to give 2 molecules of phosphoglycerate (PGA), and (b) oxygenation of RuBP to form a molecule each of phosphoglycolate and phosphoglycerate. Due to this characteristic mechanism, the enzyme is now referred to as RuBP carboxylase-oxygenase. The oxygenation reaction was proposed by Ogren and Bowes in 1971 (Ogren, W.L. Bowes, G., 1971, *Nature*, **230**, 159) based on their observation that oxygen inhibited carbon dioxide fixation by RuBP *case*. They also found that phosphoglycolate is a product of the reaction. Using $^{14}$C (U)-RuBP and $^{18}$O, Andrews, Lorimer and coworkers confirmed phosphoglycolate as a product and that one mole of oxygen was consumed for one mole of RuBP oxidized (Fig. 3).

RuBP *case* has also been shown to carboxylate RuBP to form phosphohydroxypyruvate and PGA under ultraviolet-irradiation The former decomposes to $CO_2$, and phosphoglycolate, so that there is no net $CO_2$ fixed. (Daley. or. L.S. Bidwell, R.G.S., 1976, *Plant Physiol.*, 57 (5): 25 (Abstr.). However, this reaction, requires further proof.

Siegel and Lane (1973, *J. Biol Chem*, **248**, 5486-98) reported an intermediate during carboxylation of RuBP, which was shown to be as 2-carboxy-3-ketoribitol 1,5-bisphosphate. The RuBP binding site on the enzyme involves lysine, shown by affinity labelling with 3-bromo-1,4-dihydroxy-2-butanone 1,4-bisphosphate (Norton, I.L. *et al.*, 1975, *J. Biol chem*, **250**, 8062-68).

Both catalytic activities of carboxylation and oxygenation reside on the large subunit. It is thought that the regulatory site is located on the small subunit. $CO_2$ and $O_2$ compete with one another in a linearly competitive manner for the catalytic site. Activation-inactivation properties of the enzyme showed that carboxylase and oxygenase activities varied in parallel during transitions.

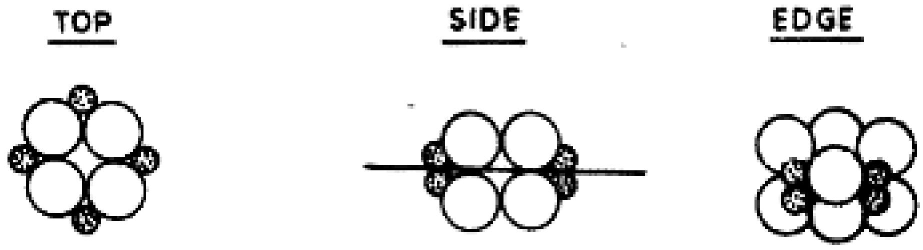

Fig. 1. Proposed model of RuBP*case* showing the arrangement of heavy and light subunits [*From* Lane and Miziroko (1978)]

Studies with carboxylase transition state analogue, substrate analogue, xylitol-1, 5-bisphosphate and the affinity label N-bromoacetyl ethanolamine also proved that the catalytic center is same for both the activities.

### Role in photorespiration and its significance

RuBP *case* activity initiates the photosynthetic carbon cycle and RuBP oxygenase diverts the carbon flow into phosphoglycolate formation and its subsequent transformations lead to the loss of carbon dioxide. This light-induced loss of carbon dioxide is known as photorespiration. According to many scientists the phenomenon of photorespiration is a wasteful process which if curtailed by suitable means will enormously increase plant productivity and crop yields. However, some people argue that photorespiration is an inevitable consequence of the active site affinity of the enzyme RuBP *case* towards $CO_2$ and $O_2$ and also it helps to prevent the photo-oxidative damage of the chloroplasts by draining out excessive energy.

The proposal to alter the carboxylase/oxygenase ratio towards the favour of carboxylation or to abolish completely the oxygenation is being given major importance in many laboratories. Many approaches were suggested to achieve this goal. R.W.F. Hardy of E.I. du Pont Nemours Co. Experimental Station (USA) found that increasing ambient con-

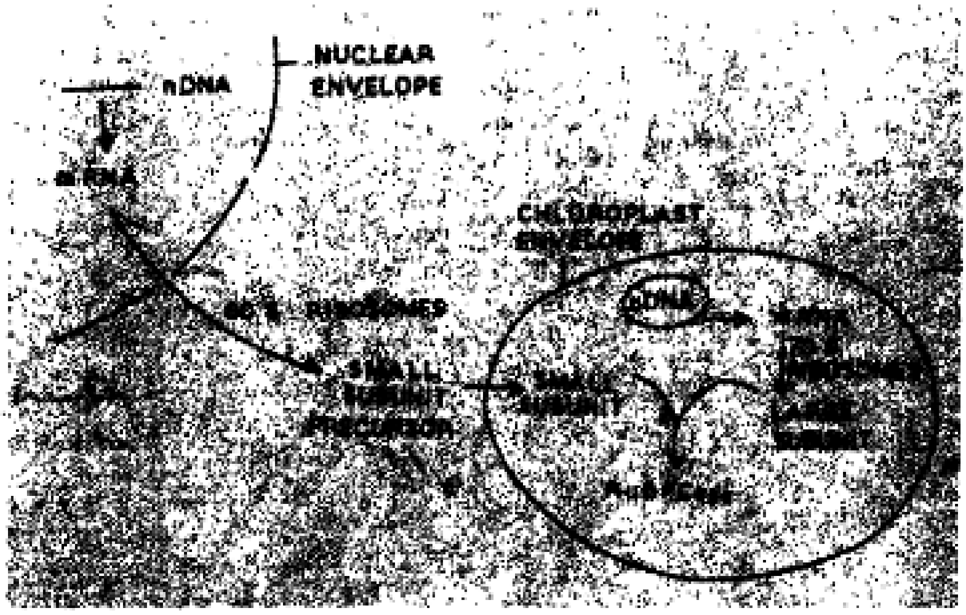

Fig. 2. A simplified model of synthesis of RuBP*case* [*From*: Ellis (1979)]

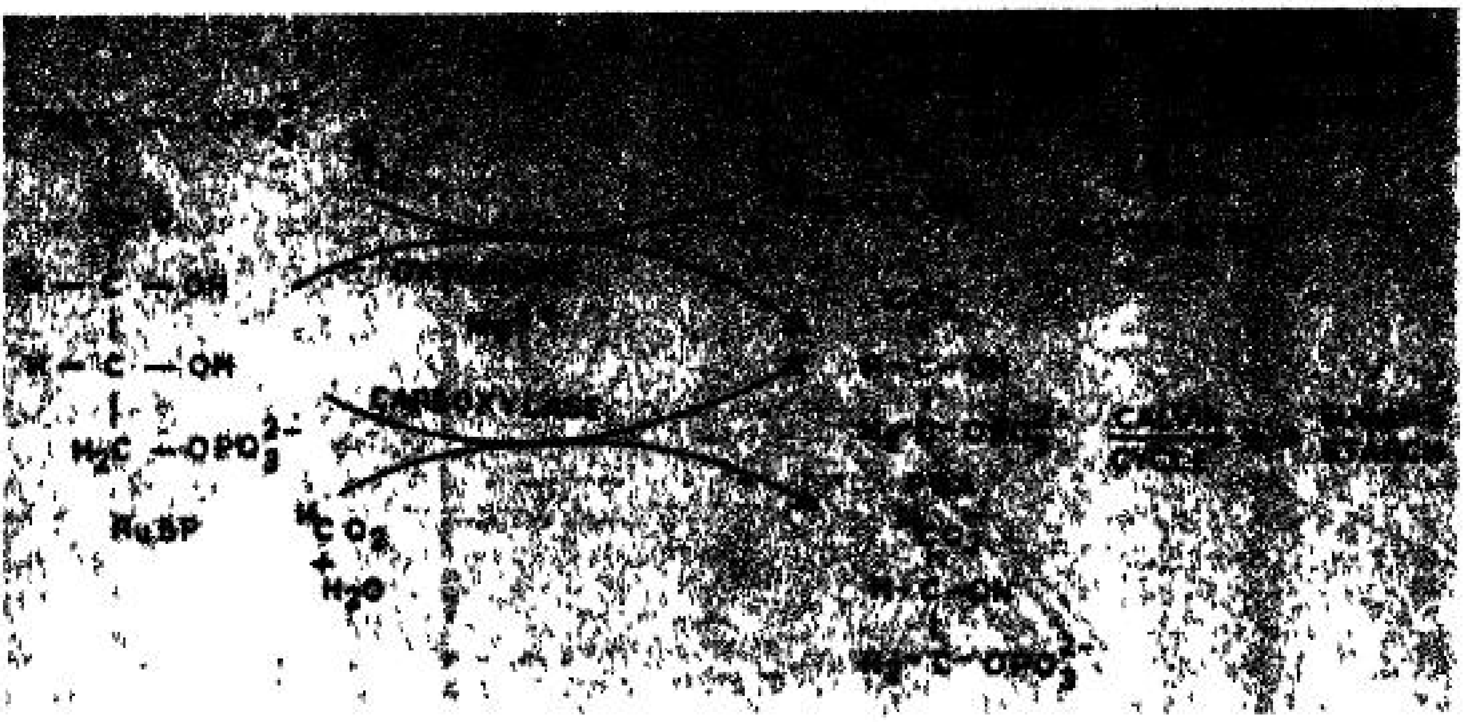

Fig. 3. Mechanism of action of RuBPcase [*From* Jensen, Bahr (1977)]

centrations of carbon dioxide around field crops was beneficial. He realized increase in seed yield of 50%-100% in three grain legumes (soybeans, peas and beans) by carbon dioxide enrichment to 1500 ppm in the canopy from anthesis to senescence. The enhanced yield is primarily due to increase in photosynthetic carbon assimilation by the elevated $CO_2$ $O_2$ ratio and to a higher degree of saturation of RuBP *case* with $CO_2$. The increase in yield were also seen in cereals (34%-50%) and cotton (51% increase in bolls per plant). This indirectly proves that the photorespiratory syndrome is a deleterious metabolic aspect.

The obvious limitation of altering RuBP *case/oase* by genetic manipulation is the segregation of genes between the nucleus and chloroplast. The conventional breeding techniques are not suitable because the large subunit of the enzyme, which contains the active site has its genetic information in the chloroplast. Lack of information regarding repressors, inducers or about the number of genes involved makes the efforts difficult. A recent report by J.D.H Keating and M.K. Garrett of improved carboxylase activity in certain tetraploid ryegrasses stimulated considerable interest (Keating, J.D.H. Garret, M.K., 1977, In IV *International Cong. Photosynthesis. Abstracts*, pp 191-192). One has to look towards the unconventional approaches such as recombinant DNA, somatic fusion and organelle transplants to develop plants with improved carboxylase system.

The selective inhibition of RuBP oxygenase by endogenous metabolities or exogenous effectors, while allowing carboxylation to continue, has been viewed as a means of increasing plant productivity. However, most of the efforts met with failure. Only recently Okabe *et al.* from the University of Dundee, U.K. reported that hydroxylamine selectively inhibited oxygenase activity and stimulated carboxylase in the *Cyanobacterium. Anabaena cylindrica* (*Nature*, 279, 225, 1979). However Sane and coworkers from BARC, Bombay

**Table 1**

| *Amino acids* | *Grams/100 gm protein*<br>*F A O provisional pattern* | *Casein* | *Tobacco fraction I protein* |
|---|---|---|---|
| Isoleucine | 4.2 | 7 5 | 4.2 |
| Leucine | 4 8 | 10.0 | 8.8 |
| Lysine | 4.2 | 8.5 | 5.8 |
| Phenylalanine | 2.8 | 6 3 | 4.4 |
| Tyrosine | 2 8 | 6 4 | 4.9 |
| Methionine | 2.2 | 3 5 | 1.6 |
| Threonine | 2.8 | 4 5 | 5.2 |
| Tryptophan | 1.4 | 1.3 | 1.5 |
| Valine | 4.2 | 7.7 | 7.2 |

*From :* S.G. Wildman & P. Kwanyhen (1978) reported that hydroxylamine inhibited the oxygenase activity but carboxylase activity was not affected.

Approaches using mutational techniques also met with failure. K. Anderson and coworkers (University of California, Davis) working with mutants of a bacterium, *Alcaligenes eutrophus*, found that in some mutants carboxylase and oxygenase activities were reduced to a similar extent and some strains lack both the activities which only proves that carboxylase and oxygenase activities are closely linked (K. Andersen, 1979, BBA, 585: 1-11). The attempts to screen for mutants by increasing oxygen concentrations in growth chambers are underway at Connecticut Agricultural Experiment Station. I. Zelitch and Mary Berlyn are employing autotrophic callus cultures of tobacco for this purpose. When they shifted the cultures from 3% $CO_2$ to 70% $O_2$ most of the cells in the cultures were rendered inviable, but for a few The viable cells were isolated and retested in high oxygen atmospheres The cultures remained viable (M Berlyn *et al*, 1978, *Pl Physiol*, 61, 606). It may be presumed that the cultures became resistant to high oxygen concentration due to altered oxygenase characteristics Similar approach can be employed to screen seedlings with suppressed photorespiratory features, in growth chambers having high oxygen concentration.

### Turnover

Experiments employing incorporation of labelled amino acids and immunoelectrophoresis have shown that virtually no turnover takes place during synthesis of the RuBP *case* enzymes. Even after the enzyme reached a steady stage concentration, turnover was not detected barley and xanthium. However, degradation of this enzyme is fast when the plant requires it reserves, *viz*., sugars, amino acids at some other sites because of environmental stresses/deficits During senescence, RuBP *case* seems to be the major protein to be degraded along with the loss of chlorophyll Simultaneous synthesis of this enzyme takes place, although at a slower rate It appears that RuBP *case* degradation is a cytoplasmically driven process From crop productivity angle, however the maintenance of high RuBP *case* activity throughout the growth and development period is necessary so that the photosynthates are available for biomass production and meeting the requirements of sink (developing seeds) for reduced carbon compounds Thus, it is essential that two pronged approach is followed, (a) identify environmental stresses, and nutritional parameters which regulate the synthesis/degradation of RuBP *case*, (b) identify genotypes which are able to maintain high levels of RuBP *case* activity through the development period Our studies on ‘nitrogen economy’ of crop plants have shown that following the present management practices and the levels of fertilizer nitrogen applied, availability of nitrogen during the seed development period is a major limiting factor contributing to lower grain and grain nitrogen harvest. The demand by the ‘sink’ results in early onset of senescence, which

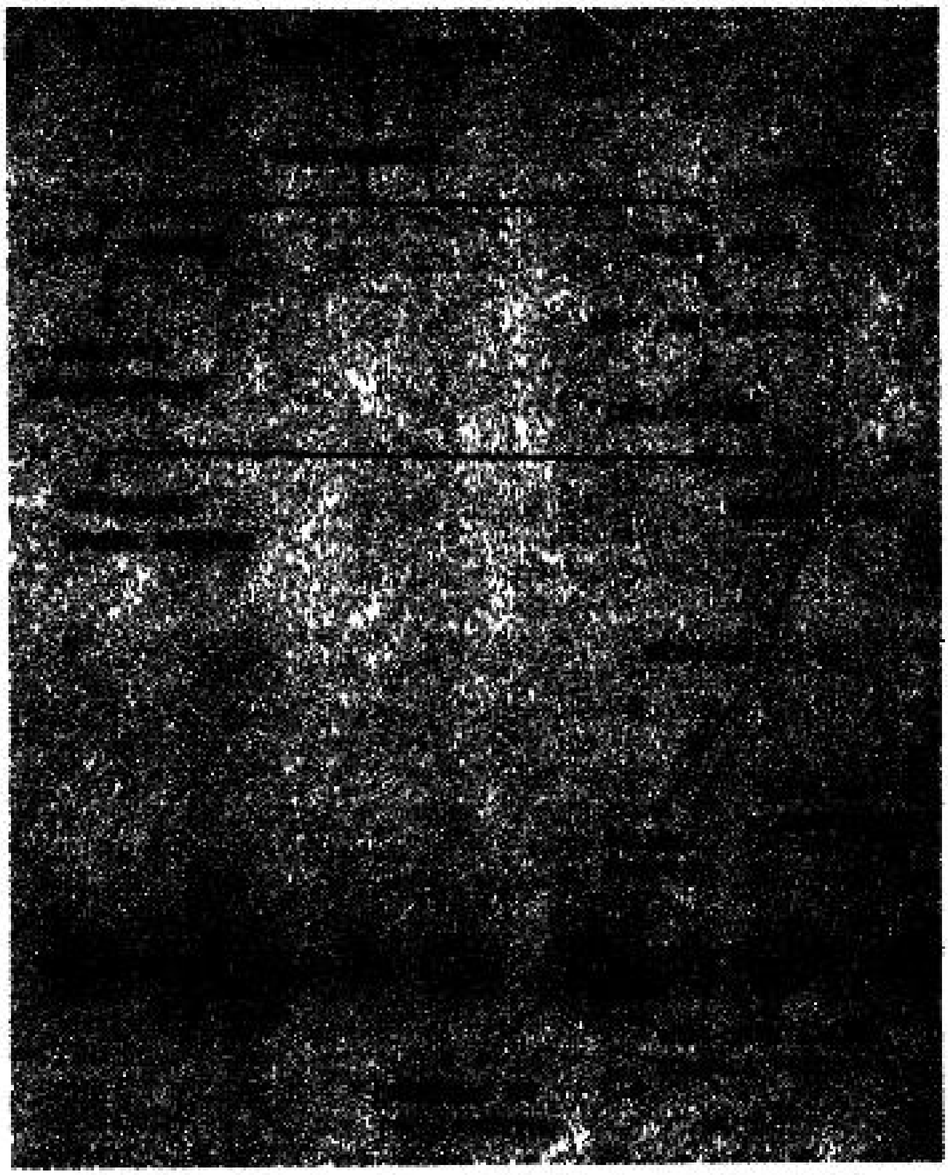

Fig. 4. Flow sheet for the isolation of fraction I protein from tobacco leaves

is coupled with degradation of RuBP *case*. This impairs the photosynthetic ability

Experiments wherein nitrogen was made available throughout the growth period have shown that this not only results in higher reduced nitrogen harvest but also in enhanced RuBP *case* activity with concomitant increase in higher grain harvest

### RuBP *case/oase* as protein food

The idea of using leaf proteins as human food supplement is not new But recently S.G. Wildman of Univ of Calif. (Los Angeles) strongly advocated the use of Fraction I Protein (RuBP *case*) from tobacco as an ideal protein supplement. Protein efficiency ratio (PER) tests proved that it is an outstanding protein from the viewpoint of nutritional value It is easy to isolate Fraction I protein from tobacco and it is economical too. Wildman got yields recrystallized Fraction I Protein as high as 3 gm to 4 gm dry protein per kg fresh tobacco The protein is odourless and tasteless in its purified form and is devoid of carbohydrates, purines, pyrimidines, pigments, etc. It also has the potential of therapeutic value, especially in feeding patients with renal diseases whose sodium and potassium intake should be rigorously controlled

The amounts of essential amino acids in tobacco Fraction I protein exceed the standards of the provisional pattern set by FAO. A comparison is given in Table I. The procedure to extract edible protein from tobacco is given in Fig. 4.

This process has also additional advantages. The leafy residue obtained in the first step can be used for cigarette manufacture, which will be virtually harmless if the carcinogens can be removed or neutralized from tobacco when it is in slurry form This process of homogenized leaf curing (HLC) also facilitates complete mechanization of tobacco leaf curing process according to D.W Dejong (1979)

### Further reading

1. Kawashima, N, Wildman, S G. (1970), Fraction I Protein, *Ann. Rev. Plant Physiol.* **20**, 325-358
2. Seigel, M.I.; Wishnick, M.; Lane, M.D. (1972), Ribulose 1, 5-bisphosphate carboxylase, In: *The Enzymes*, P.D. Boyer, pp. 169-192, Academic Press, N.Y.
3. Burris, R.H.; Black, C.C.; (Eds). (1976), $CO_2$ *metabolism and crop productivity*, University Park Press, Baltimore, Md. (U.S.A.)
4. Jensen, R.G, Bahr, J.T. (1977), Ribulose 1, 5-bisphosphate carboxylase-oxygenase, *Ann. Rev. Plant Physiol*, **28**, 379-400.
5. Hall, D O., Combs, J, Goodman, T.W (Eds.). *Proc. 4th International Cong. Photosynthesis*, Biochem Soc, London (1977)
6. Siegelman, H.W, Hind, G (1978), *Photosynthetic carbon assimilation* Plenum Press.
7. Marcelle, R.; Clysters, H.; Poucke Van, M. (1979), *Photosynthesis and Plant Development*, Junk Den Haag.

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## FOR HER *(Continued from page 800)*

*fragilis* find a favourable ground. Such babies exhibit higher morbidity and higher mortality due to intestinal infections.

### Conclusion

Human milk gives the young infant some protection against infections by reason of living phagocytic cells, specific antibodies derived from the mother and IgA, and by the lactoferrin and lysozyme which it contains It can also be noted that from the point of view of host, lactic acid bacteria are an indispensable and regular feature for the maintenance of proper health. All these factors make human milk superior in biological value for infant. Breast feeding should therefore be encouraged for the healthy development of infants.

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*Divn. of Diary Microbiology*
*N.D.R.I., Karnal-132001*

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## THE PIGS *(Continued from page 775)*

annum, can produce 150 piglets which, when fully grown, can weigh 70 kg each and yield a net profit of Rs. 6500 a year

### Further reading

1. Britt, Kent (1978), The joy of pigs, *National Geographic*, Washington, Vol 154, No. 3. (September 1978), pp. 398-415.
2. CSIR (1970), *The Wealth of India*, Suppl. Livestock (including poultry), Publ. Directorate, C.S.I.R., New Delhi, Vol, VI, pp. 124-137.
3. *Grzimen's Animal Encyclopaedia* (1972). Van Nostrand Reinhold Company, New York, Cincinnati, Toronto, London, Melbourne, pp 76-108 (Swine and peccaries).
4. *Enyclopaedia Britannica* (1973), Vol. 17, pp. 1068-1072.
5. Prater, S.H (1965), *The Book of Indian Animals*, Bombay Natural History Society, Bombay, 2nd Rev. Edn., pp. 298-300 (pigs).

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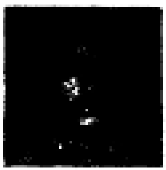
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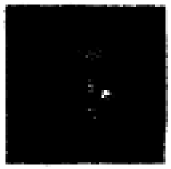
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# THE PIGS

B.K. BEHURA

**Pigs are not only efficient converters of agricultural by-products, particularly wastes into high quality meat, but also provide pig skin, fat, hormones, etc., to man**

**Fig. 1. (Facing page) Artiodactyla (even-toed hoofed mammals); 1. Spotted deer, 2. Camel. 3. Four-horned antelope, 4. Wild goat (Ibex), 5. Hippopotamus, 6. Giraffe, 7. Gaur, 8. Wild buffalo, 9. Marcopolo's sheep**

PIG, or the swine, is a well-known quadruped with bristly skin and long snout. Zoologists include the animal under Artiodactyla, a large order of cloven-hooved or even-toed hoofed mammals which includes a wide variety of species such as the antelope, hippopotamus, camel, deer, sheep, goat, giraffe, bison and cattle (Fig. 1). The more readily observed features of the order are to be found in the structure of the feet, characterized as *paraxonic*, or having the axis of symmetry between the third and fourth digits in contrast to the odd-toed hoofed mammals, the Perissodactyla (horse, ass, zebra, tapir and rhinoceros) (Fig. 2), which are mesaxonic, i.e., have the axis of symmetry through the third digit. The order Artiodactyla is composed of three sub-orders : Suiformes, Tylopoda and Ruminantia (Table 1). The suborder Suiformes comprises three families : *Suidae* (Old world pigs), *Tayassuidae* (Peccaries or New world pigs) and *Hippopotamidae* (Hippopotamuses).

Suiformes are bunodent, i.e., their molar teeth have rounded cusps or tubercles as in man. They are otherwise known as Bunodontia. In these animals, the canines are tusk-like. In the wild boars and hippopotamus, all the four types of teeth characteristic of mammals—incisors, canines, premolars and molars—are present, while in the adult wart hogs incisors and anterior premolars are commonly lacking (Table 3).

## Old world pigs

The old world pigs belong to eight different species and five genera, *Sus*, *Phacochoerus*, *Babirussa*, *Potamochoerus* and *Hylochoerus* and are widely distributed (Table 2). The European wild boar, the Javan or Celebes wild pig, the Bornean wild boar or the white-whiskered swine, the Indian wild boar and the Pygmy hog—all belong to the genus *Sus* while the African warthog and the Babirussa of Celebes and Molucca Islands belong to the genus *Phacochoerus* and *Babirussa* respectively. The Red river hog or Bush pig of Africa and Malagasy belong to the genus *Potamochoerus* and the forest hog of Africa comes under the genus *Hylochoerus*. Thus the greatest diversity of genera of pigs occurs in Africa.

Members belonging to the family *Suidae* are of moderate size, the elongated head ends in a snout and their body is covered with bristles. They are terrestrial and have an omnivorous diet. The females are prolific and have many teats to serve the large litters. Their voice is a well-known grunt.

## The wild boar

The principal and best known species is the wild boar, *Sus scrofa*, which still ranges over a wide area from Europe to Central Asia and from the Baltic to North Africa. All the breeds and varieties of domestic pigs are descended from this species and are the result of long and careful selective breeding. It is believed, probably there was an admixture of the blood of *Sus scrofa* with its closely related Asiatic species, *Sus vittatus*.

The wild boar is a fierce forest dwelling animal. Its elongated head ends in a cartilagenous disc—the snout—in which the nostrils are situated. The skin is thick and covered with short stiff hair called bristles. Tail is straight and hangs down and, unlike the domestic pig, is never coiled up. Eyes are small and ears large and mobile. Smell and hearing are their best developed senses. The lower canines rise straight up outside the mouth and then curve backwards to point towards the eyes. These act as powerful organs of offense and defence. The older males lead solitary life after the breeding season. The females and young males live in herds. The wild boars display great intelligence, courage and determination. They are omnivorous, feed

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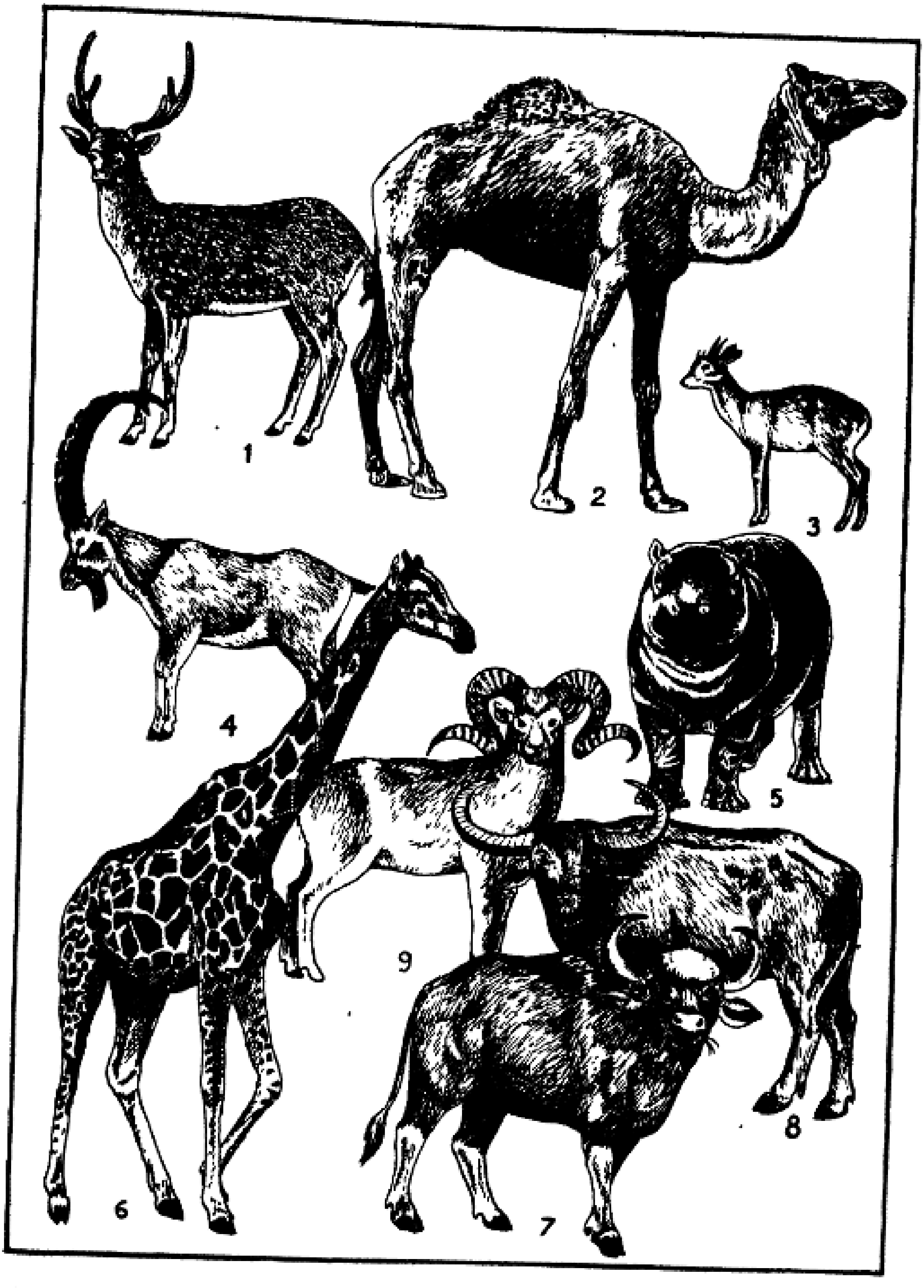
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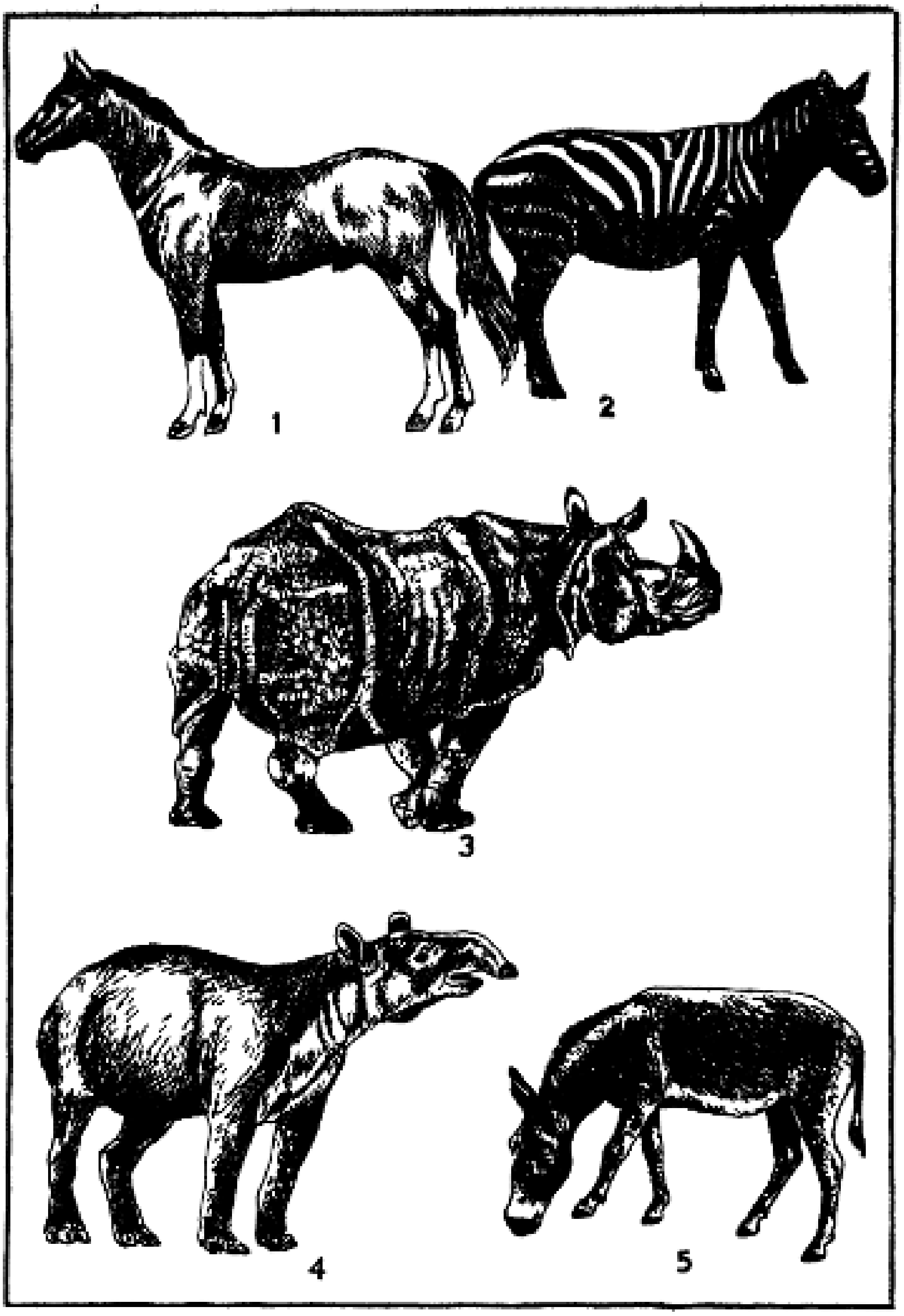


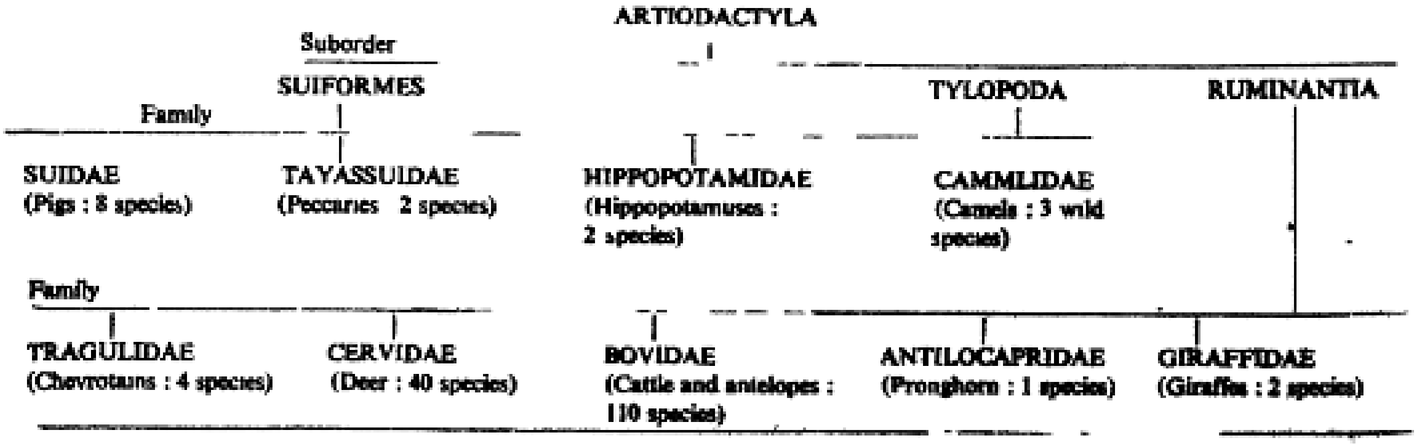
**Fig. 2. Perissodactyla (Odd-toed hoofed mammals); 1. Horse, 2. Zebra, 3. One horned rhinoceros, 4. Tapir, 5. Indian wild ass**

ing on roots, tubers, insects, snakes and carrion They destroy crops to a large extent.

**Indian wild boar**

The Indian wild boar, *Sus scrofa cristatus* has a wide distribution ranging over nearly the whole of India, Burma, Tenasserim, Siam, part of Malay Peninsula and Sri Lanka The Indian wild boar differs from its counterpart in Europe, *Sus scrofa scrofa*, in that the crest or mane of black bristles running from the nape down the back is much more well developed and the body is less hairy in contrast to the thick coat of bristles in consonance with the cold climate A well-grown male stands 90 cm at the shoulder and weighs 230 kg The tusks measure upto a maximum of 32 1 cm outside the curve There appears to be no definite rutting season In central India, the majority of young are born shortly before and after the rains. Boars and sows collect in large numbers for pairing Males fight for females. The period of pregnancy is about four months. Usually four to six youngs are born in a litter The sow gathers a heaped up mass of grass and leaves in a quiet spot

**Table 1**



ARTIODACTYLA

Suborder
SUIFORMES
TYLOPODA
RUMINANTIA

Family
SUIDAE
(Pigs : 8 species)
TAYASSUIDAE
(Peccaries 2 species)
HIPPOPOTAMIDAE
(Hippopotamuses : 2 species)
CAMMLIDAE
(Camels : 3 wild species)

Family
TRAGULIDAE
(Chevrotains : 4 species)
CERVIDAE
(Deer : 40 species)
BOVIDAE
(Cattle and antelopes : 110 species)
ANTILOCAPRIDAE
(Pronghorn : 1 species)
GIRAFFIDAE
(Giraffes : 2 species)

where she gives birth to the young. The young are brown and striped. The light or black stripes later disappear, an interesting proof of their wild ancestry.

In the forests of the Andaman and Nicobar Islands live two distinct subspecies of wild boar *Sus scrofa andamanensis* and *Sus scrofa nicobaricus* respectively.

## The pigmy hog

The pigmy hog, *Sus salvanius* (Fig. 3), is an endangered species having been listed in the Red Data Book of the International Union for the Conservation of Nature and Natural Resources (IUCN). As the name implies it is scarcely more than 25 cm high at the shoulder and inhabits the Himalayan Terai, from Uttar Pradesh to Assam. It was first described in 1847 by Hodgson on a specimen obtained from Sikkim. It is a diminutive form of the wild boar. Its ears and tail are short and devoid of hair. The number of teats is six in stead of four pairs as in the wild and domesticated swine. The coat of the adult is blackish brown. The young are striped brown with the underparts white. The weight of the full grown boar varies from 3.5 kg to 4.5 kg and rarely 6 kg.

The pygmy hog lives in the tall grass jungles of Sal (*Shorea robusta*) of the Terai region in the base of the Himalayas. It is social and found in small herds of 5 to 20. They are diurnal being active after dawn and before sunset. They hide during the day in tall grass. The old males live with the herd and defend the family with courage. Little is known about their pairing habits. They breed twice a year and bring forth 3-4 young in a litter. Their food chiefly consists of roots, bulbs, insects, lizards and birds.

## Bush pig

Close to the wild boars are the bush pigs. The Red river hog, *Potamochoerus porcus* (Fig. 3), living in wide areas of Africa, with a related form in Malagasy, is similar to the wild boar in general appearance, snout, bristles and longitudinal stripes in the young. Its coat is reddish, while old males may be black. The face is grey and the mane is white. Ears are pointed and end in tufts of hair. The bush pig lives in herds in thickets and like the wild boar of India causes great damage to crops.

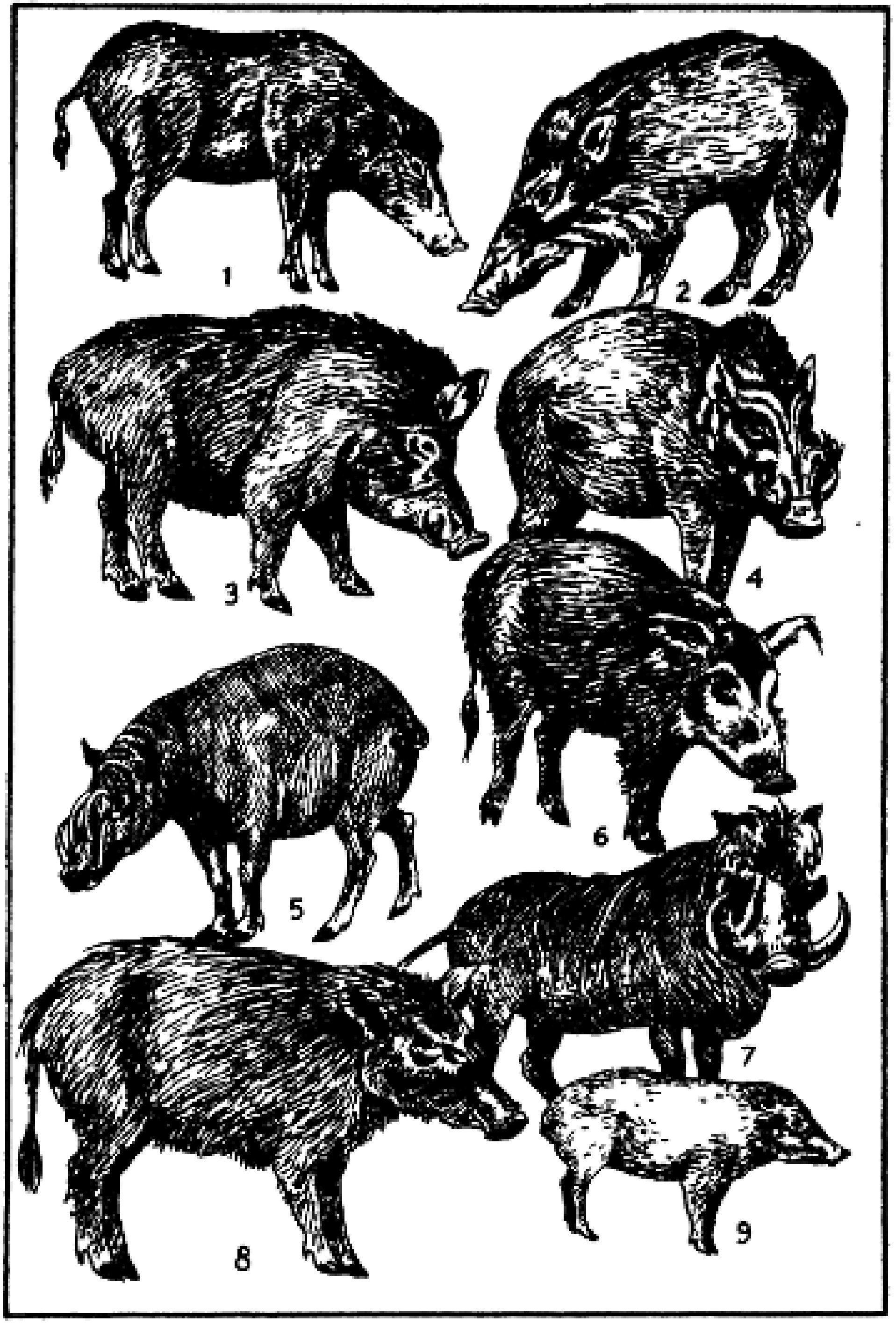


Fig. 3. Old world pigs, 1. Indian wild boar, 2. Bearded pig, 3. European wildboar, 4. Javan wild pig, 5. Babirussa, 6. Bush pig, 7. Wart hog, 8. Forest hog, 9. Pygmy hog

## Wart hog

Another wild swine is the wart hog, *Phacochoerus aethiopicus*, which lives in Senegal and Ethiopia in Africa. It derives its name from the large wart-like excrescences on the cheeks. It is ugly looking specially because of its enormous head, flat muzzle, two sets of curved tusks and three pairs of warts growing out between the snout and the eyes. It is half-hairy, half-naked and measures 1.5 m in length and 0.6 m at the shoulder. It digs up roots and tubers and feeds on them. When alarmed, the family runs for cover in single file with tails raised at a speed of about 48 km per hour.

The forest hog, *Hylochoerus meinertzhageni*, is yet another African pig living in the deep forests from equatorial Africa to Liberia. It was first discovered in Kenya in 1904. It resembles wart hog, but little is known about it.

**Babirussa**

Another member of *Suidae* living in the Celebes and Molucca Islands is the babirussa, *Babyroussa babyrussa*. Babirussa, the native name of the animal, means pig deer. It possesses enormous canines, especially the upper ones which grow upwards to curve almost into a circle. No satisfactory explanation is available to explain the enormous growth of the canines in this animal. It may be explained by orthogenesis alone which means evolution in a definite direction, irrespective of natural selection or external forces. The Babirussa is more aquatic than other *Suidae* and lives in marshy forest areas. One or two young are brought forth at a time.

**Table 2. Old world pigs**

| | | | *Distribution* |
|---|---|---|---|
| 1. | European wild boar: | *Sus scrofa* | Europe and Asia |
| 2. | Celebes<br>or<br>Javan wild pig : | *Sus verrucosus* | Java, Borneo, Sumatra, Celebes and Philippines. |
| 3. | Bornean wild boar<br>or Bearded pig<br>or White-whiskered swine | *Sus barbarus* | Borneo, Sumatra, Malay Peninsula |
| 4. | Pygmy hog : | *Sus salvanius* | India, base of Himalayas in Sikkim, Nepal, Bhutan and Assam |
| 5. | Red river hog<br>or<br>Bush pig | *Potamochoerus norcus* | Africa, related form in Madagascar |
| 6 | African warthog | *Phacochoerus aethiopicus* | Africa |
| 7. | Babirussa | *Babyrousa babyrussa* | Celebes and Molucca Islands |
| 8. | Forest hog | *Hylochoerus meinertzhageni* | Africa |

**Table 3. Dentition in suiformes ( Bunodontia)**

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Wild boar | I. | $\frac{3}{3}$ | C | $\frac{1}{1}$ Pm | $\frac{4}{4}$ | M. $\frac{3}{3}$ | Total | 44 |
| Hippopotamus | I. | $\frac{2}{2}$ | C. | $\frac{1}{1}$ Pm. | $\frac{4}{4}$ | M. $\frac{3}{3}$ | Total | 40 |
| Wart hog (young) | I. | $\frac{1}{3}$ | C. | $\frac{1}{1}$ Pm | $\frac{2}{1}$ | M. $\frac{3}{3}$ | Total | 30 |

**Table 4 Production of meat from slaughtered animals in India**

*(000 tonnes)*

| | 1961-65 | 1972 | 1973 | 1974 | 1975 | 1976 |
|---|---|---|---|---|---|---|
| Beef & Buffalo Meat | 160 | 182 | 186 | 187 | 188 | 189 |
| ——Beef and Veal | 60 | 68 | 70 | 71 | 71 | 72 |
| ——Buffalo | 106 | 114 | 116 | 116 | 117 | 117 |
| Mutton & Goat Meat | 353 | 377 | 384 | 384 | 386 | 387 |
| ——Mutton & Lamb | 109 | 114 | 116 | 116 | 117 | 117 |
| ——Goat Meat | 244 | 263 | 268 | 268 | 269 | 270 |
| Pig Meat | 43 | 52 | 53 | 55 | 56 | 58 |
| Poultry Meat | 70 | 90 | 95 | 100 | 101 | 103 |
| Total | 684 | 781 | 802 | 813 | 821 | 829 |

*Source :* FAO Production Year Book, 1972-76

**Evolutionary background**

The wild boar evolved some 36 million years ago in early Oligocene. Evidence is available about their distribution in Europe, Africa and Asia during early Miocene, about 25 million years ago. *Palaeochoerus* of late Oligocene is regarded as the architype of the true pig family.

History has it that in 2900 B.C. wild pigs were first domesticated and eaten in China. There are more than 300 hog breeds which are the result of long and careful selective breeding. The domesticated pig is much different from the wild boar in appearance and temperament. It is short legged, has a much less hairy body, shorter jaws, smaller teeth, eyes that look forwards rather than sideways, large deposits of fat and have curly instead of straight tails. The domesticated swine of Europe (*Sus scrofa domestica*) is the descendent of the European wild boar *Sus scrofa scrofa*. The famous Hampshire pig was first bred in England and was taken to the United States of America by the famous explorer Columbus where it is now raised in thousands. A typical pig farm in the U.S.A. accommodates 11,000 to 12,000 swine, sending 18,000 a year to the slaughter house. Adult hogs weigh about 362.87 kg, the record being 863.64 kg. Their life span is about 15 to 20 years. There are 8 to 12 in a litter, 34 being the record.

## Utility

Pigs serve mankind in various ways. They are efficient converters of agricultural byproducts, particularly wastes, into high quality meat. Their marked economic characteristics are prolific breeding, early maturity and rapid fattening. In the United States of America some 75 million hogs are slaughtered every year to provide pork for a nation of 219 million people, the average consumption being 29.5 kg per head. Apart from the rich proteinous value of sweet ham, bacon and pork, they contain vitamins including niacin and thiamin. Sixty-five per cent of a swine's body accounts for pork and lard. From the rest are produced more than 500 products. The hog's hide makes fine pigskin leather for shoes, handbags and foot-balls. Swine's coarse hair is used for production of hair brushes. The fat of pig is used for the production of lard, machine oil, dynamite, soap and shaving cream. With swine's bones, glue and fertilizers are produced. From the glandular secretions of hogs are produced various preparations for the treatment of human diseases such as insulin for diabetes, thyroxine for the underactive thyroids, ACTH for alleviating pain in arthritis, leukemia and rheumatic fever. Pigskin specially treated and sterilized is used to relieve pain in burn injuries. It is applied to the burn-exposed skin to serve as a protective covering until the victim's own skin grows up.

In the Perigord region of France world's best black truffles, a kind of fungus grow. They sell $ 200 per half kg. This fungus grows 5 cm to 30 cm below ground. In order to sniff out the location of truffles underground female pigs and dogs are used as *chercheuses* or searchers.

## Piggery in India

The population of pigs in India is estimated at 6.81 million. One and a half million swine are slaughtered annually for the production of meat. It is estimated that 8,30,000 metric tonnes of meat are produced in the country, of which 46.7 per cent is from sheep and goat, 22.8 per cent from cattle, 12.4 per cent from poultry and 7 per cent from pigs. There are about 27 pig-breeding farms and 7 bacon factories in India. Among the swine breeding farms, mention may be made of piggeries at Haringhata (Karnataka), Aligarh (U.P.), Ambala (Punjab) and Hissar (Haryana). Amongst states, largest concentration of pigs occurs in Uttar Pradesh.

Selection of breed plays a significant role in piggery as an industry. Exotic breeds such as Berkshire, Large-white Yorkshire, Middle-white Yorkshire, Landrace Hampshire, Tamworth and Wessex Saddleback have been introduced in India from the United Kingdom and other European countries. However, no record is available as to when the first and subsequent imports took place.

In a piggery, a well maintained year old boar starts serving sows at the rate of 60 per year till it reaches the age of six. It is not allowed to mate with more than one sow a day. While selecting breeding sows, care is taken to ensure that they do not have thick, coarse head and ears.

**Table 4. Distribution of pig population in India in 1961 (in thousands)** *Source : The Wealth of India*, **Suppl. Vol. VI (CSIR)**

| *State* | *No.* |
|---|---:|
| Andhra Pradesh | 592.7 |
| Assam | 451.9 |
| Bihar | 807.9 |
| Gujarat | 5.2 |
| Jammu and Kashmir | 0.2 |
| Kerala | 122.4 |
| Madhya Pradesh | 343.0 |
| Madras | 502.3 |
| Maharashtra | 191.6 |
| Mysore | 206.5 |
| Orissa | 208.6 |
| Punjab | 138.9 |
| Rajasthan | 71.5 |
| Uttar Pradesh | 1,161.5 |
| West Bengal | 134.4 |
| Delhi | 12.6 |
| Himachal Pradesh | 2.4 |
| Manipur | 123.1 |
| Tripura | 35.2 |
| Andaman and Nicobar Islands | 14.2 |
| Laccadiv, Minicoy and Amindive Islands | * |
| Pondicherri | 1.2 |
| Total | 5,177.3 |

Within a few days of their birth piglets are injected with iron dextron to prevent anaemia. When 6 to 8 weeks old, they are vaccinated against hog cholera and swine plague.

Pigs are housed and protected against excessive heat, rain and cold. Damp places and overcrowding should be avoided.

A small unit involving 10 sows and one boar requiring a capital investment of about Rs. 5000 and working funds of Rs. 18,000 per

(*Continued on page 768*)

# SCIENCE SPECTRUM

## Solar pond

SOLAR energy is free and abundant but is of relatively low intensity and of intermittent nature. So, a large scale acceptance of solar energy in the immediate future hinges upon the development of effective low cost solar collectors and storage systems. Solar collectors and storage systems with varying degrees of complexities and utility are now known. The solar pond is a unique type of solar heat collector which combines in itself the collection and sensible heat storage characteristics. The physical phenomenon of solar pond has been known since the turn of the century. The practical utilisation of this phenomenon has emerged from man's curiosity to collect solar energy on a large scale by using a black bottomed water pond.

In practice, a water pond has very poor collection efficiency. This is because the heated water at the bottom rises by convection to the top where heat is readily dissipated to the surroundings. This loss of heat can be prevented if the convection is impeded and this is done by creating a density gradient using stratified salt solutions. Such a situation occurs in nature in some Hungarian lakes which have been observed to attain temperatures of about 70°C at a depth of 1.5 m by solar heating. Based on this principle, artificial salt gradient stabilized ponds called 'Solar ponds' have been developed in India, Israel and the U.S.A. A schematic diagram of a solar pond is shown in Fig. 1.

To understand how a solar pond acts as a heat trap, let us compare the behaviour under sunlight of two ponds, one of which is convective and is filled with homogenous water and the other one non-convective in which a salt concentration gradient is maintained with the lighter fresh water on top and heavier salt water at the bottom. In the convective pond, each small volume of water can be regarded as exchanging its heat directly with the atmosphere. In contrast, in the second pond (the solar pond), the same upper layer of the solution remains in contact with the atmosphere and heat is only lost from lower regions by conduction to upper regions first and then to atmosphere, primarily by evaporation, wind convection and long wave radiation to the sky. Further, since a stationery water layer is a good thermal insulator, the heat conducted from lower regions to upper regions is very small.

### Formation and maintenance of stable density gradient

The initial salt concentration gradient in the solar pond is created by various methods. One of the earliest methods has been to fill the pond with several layers of salt solution with successive layers changing stepwise in concentration from near saturation at the bottom to fresh water at the top. For a typical pond

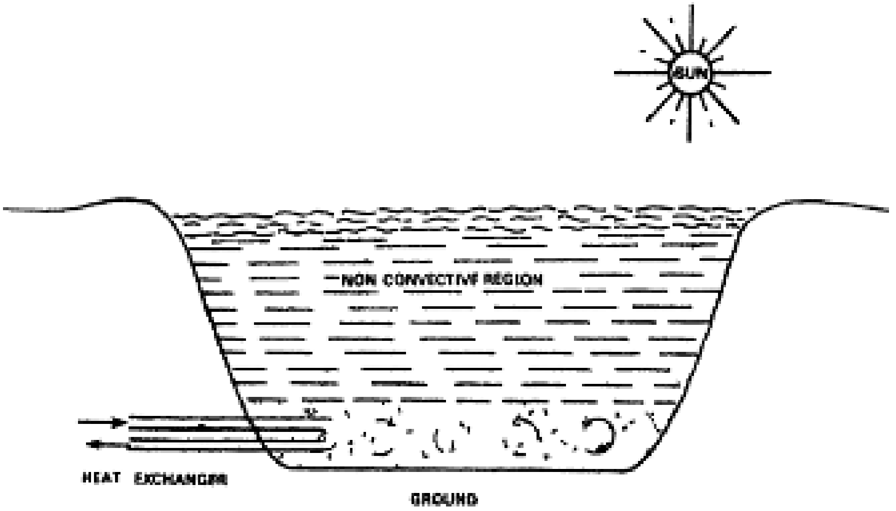


Fig. 1. Non-convective region, the region of upward decreasing salt concentration, acts as partially transparent blanket that let the solar energy in and retains it there

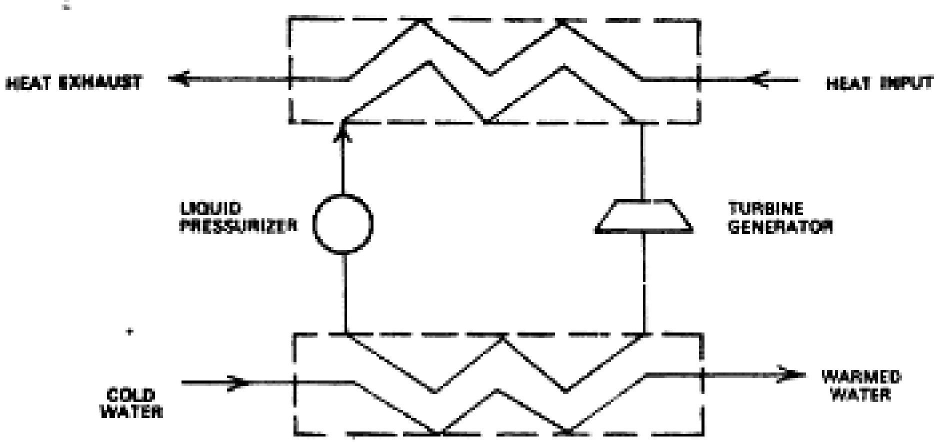


Fig. 2. Solar pond power: basic essentials of solar pond power system

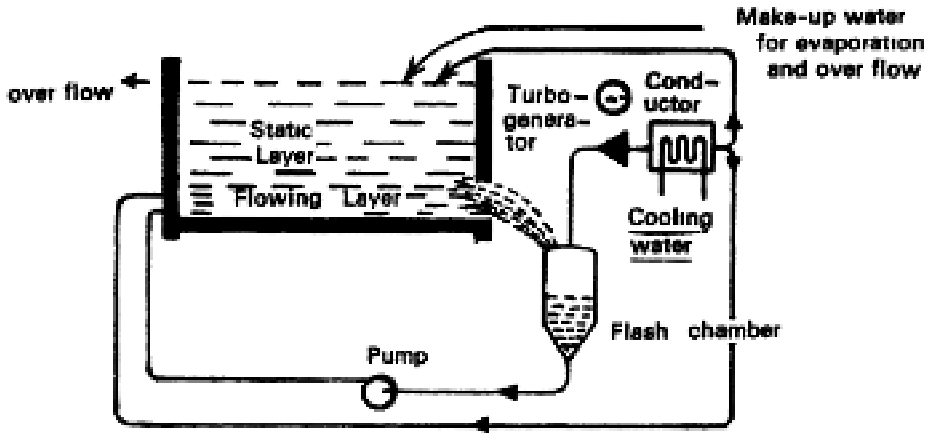


Fig. 3. Schematic representation of the 'falling pond' method of extracting heat from the bottom of a pond.

of about 1 m depth, one might use six or seven layers. Less dense layers can be 'floated' successively on the top of the existing ones or successively more dense layers can be put gradually at the bottom, lifting the whole pond. The maintenance of the salt concentration is done by periodically introducing concentrated salt solution at the bottom and washing the surface with fresh water.

## Applications

In solar heat utilization systems it is not enough to capture and store solar thermal energy, it must be done cheaply. Solar ponds meet both these requirements. Solar ponds involve a simple technology and their working materials (water and salt) are available in abundance Solar pond has been proposed as a source of solar heat for power production, multi-effect distillation plant, heating and cooling of buildings, environmental control in greenhouses, process heating, etc. The efficiency of heat extraction from a solar pond is about 30% at an extraction temperature of 100°C. So solar pond holds promise as an inexpensive and efficient method of solar energy utilisation.

## Solar power production

Electric power production from the solar pond is one of its most interesting applications. A 100 KW electric power production plant using the solar pond is already in operation in Israel. The basic essentials of a solar pond power system are shown in Figs. 2 and 3. A solar pond power plant employs a working substance such as ammonia which circulates in a closed cycle. It is estimated that in a tropical climate a solar pond of 1 sq. km. surface area should yield $30 \times 10^6$ kWh annually. Some typical calculations on the cost and efficiency of power production are given below.

Optimum efficiency of heat extraction from the solar pond at 95°C $= 27\%$ $(\eta_H)$

Efficiency of Carnot engine operating between 95°C and surrounding temperature, (25°C) is $\eta$ carnot

$$= 1 - \frac{273+25}{273+95} = 20\%$$

Efficiency of solar Energy to mechanical energy conversion is

$$\eta_M = \eta_H \times \eta_{carnot} = 5.4\%$$

Efficiency of solar energy to electricity conversion is

$$\approx \frac{1}{3}\eta_M = 1.8\%$$

Annual average solar insolation at New Delhi $= 230\ W/m^2$ So electricity obtainable $= 4.15\ W/m^2$

It is estimated that this yield of electricity should cost around 40 paise per kWh.

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# Green-houses and green-house effect

THE energy released from the surface of the sun is mainly in the form of electromagnetic radiation. Although the wavelengths of the radiation range right across the spectrum, visible light (40 per cent) and infrared (heat) radiation (50 per cent) predominate. Of the $3.9\times10^{26}$ joules of energy radiated each second by the sun, the earth intercepts only $1.75\times10^{17}$ joules or $1.52\times10^{18}$ kWh per annum. This compares with a total consumption of $7.5\times10^{13}$ kWh in one year. Not all the intercepted solar radiation reaches earth's surface, the atmosphere reflects back at least 30 per cent —perhaps as much as 50 per cent.

Of the energy retained, the atmosphere, land surfaces and the oceans absorb about two-thirds as heat energy. The hydrological cycle takes up much of the remaining one-third of the radiation in evaporating water. A much smaller proportion (about 0.2 per cent) is responsible for atmospheric and oceanic convections and ocean waves. The energy of wind and waves is therefore solar in origin. Photosynthesis in plants takes upon even smaller proportion—as little as 0.02 per cent of the solar energy retained by the earth.

## Solar greenhouses

The term solar greenhouse generally refers to greenhouses whose heating and light requirements are largely met by the sun. Most solar greenhouses collect and store energy for heating and are insulated to retain this heat for use at night and during clouds. It is perhaps this characteristic that distinguishes a solar greenhouse from a conventional glasshouse. An attached solar greenhouse (Fig. 1) is unique in that it serves the dual function of growing food and producing usable heat. The unit provides a bright, warm recreation and living area for the entire family in winter. Throughout this period the highest temperature in the greenhouse averages 26°C, and the family can harvest a fresh green salad every other day. Several plantings and transplantings of leafy vegetables, tubers, root crops, herbs and flowers keep a good harvest growing round the year at current market prices.

## Design and working

Although these designs come from a North American environment, it seems very likely that they are also useful for the highlands of tropical countries or any colder areas of the globe where space heating is a priority. Attached greenhouses employ a 'passive' solar heating concept. The structure acts both as a collector and a storage unit for solar energy through the heat absorbing combination of glass or plastic, concrete, adobe (unburnt sun-dried brick) and water-filled containers. During day hours, the last three of these substances store heat. At night, they radiate it to living spaces.

An example of solar greenhouse is shown in Fig. 2. This 185.8 $m^2$ solar house is located in the foothills near Santa Fe, New Mexico, at 36°N latitude and an elevation of 2226.5 m. All rooms face a 6.1 m high, triangular greenhouse whose south wall is 37.16 $m^2$ of thermopane (commercial double-glazed units), some of which are at a 60 degree slope. The other two walls are of adobe mud bricks (10.16 × 25.40 × 35.56 cm) set with mud mortar.

Heating air is drawn off the top of the greenhouse by two small (1/3 hp) fans and blown through two rock beds located directly under the floors of the living room and the kitchen/dining room (Fig. 2). The rock beds are 0.61 m deep and 3.05 m wide. They contain a total of 50 tons of 10.16 cm to 15.24 cm round riverbed rock which can store enough heat for the house in cloudy days. A flat-plate collector array provides domestic hot water. The north-facing side of the house is sunk 1.38 m into the ground and the low grade walls are made fo

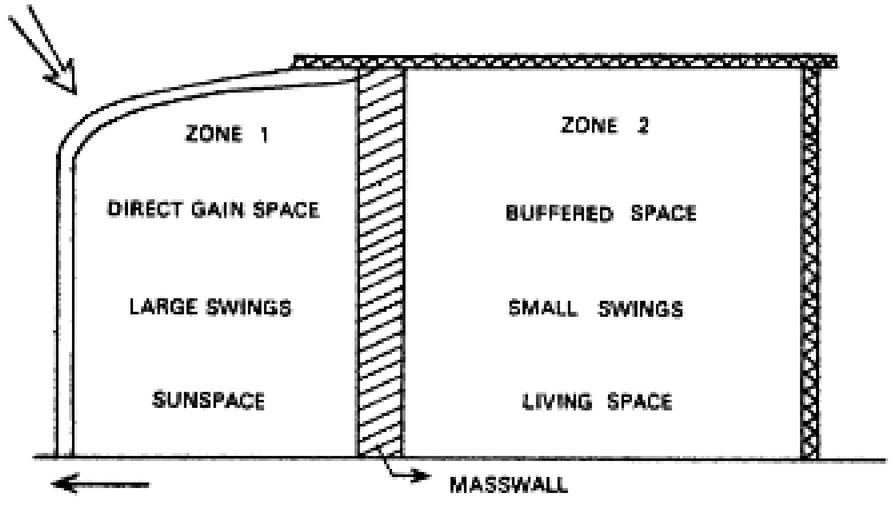

Fig. 1. Attached solar greenhouse (zone-1) buffers temperature swings in the living space (zone-2)

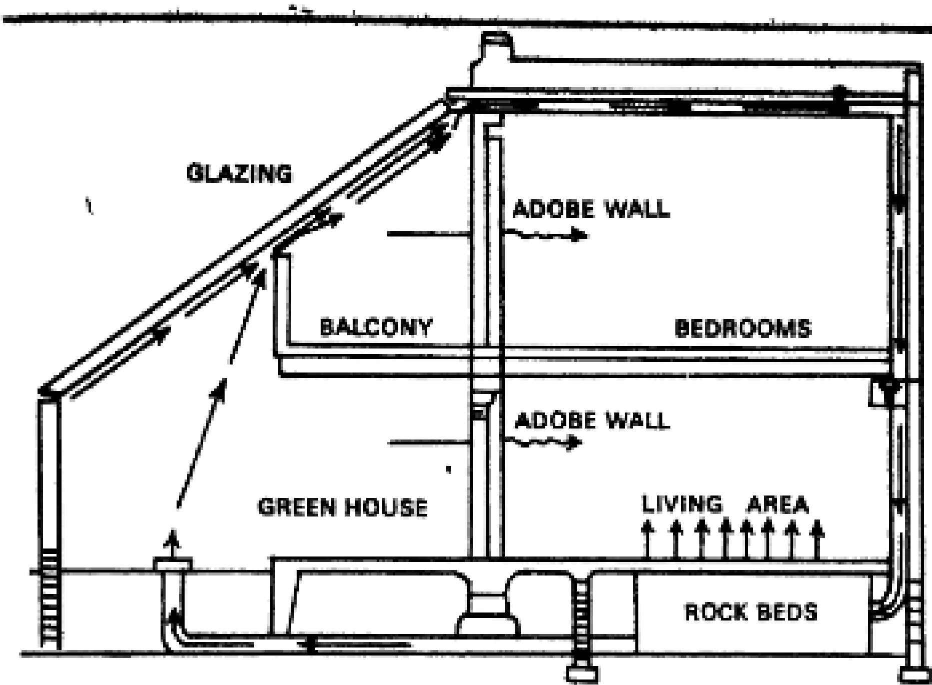

Fig. 2. Pattern of winter heat flow in the First Village* house (near Santa Fe, New Mexico)

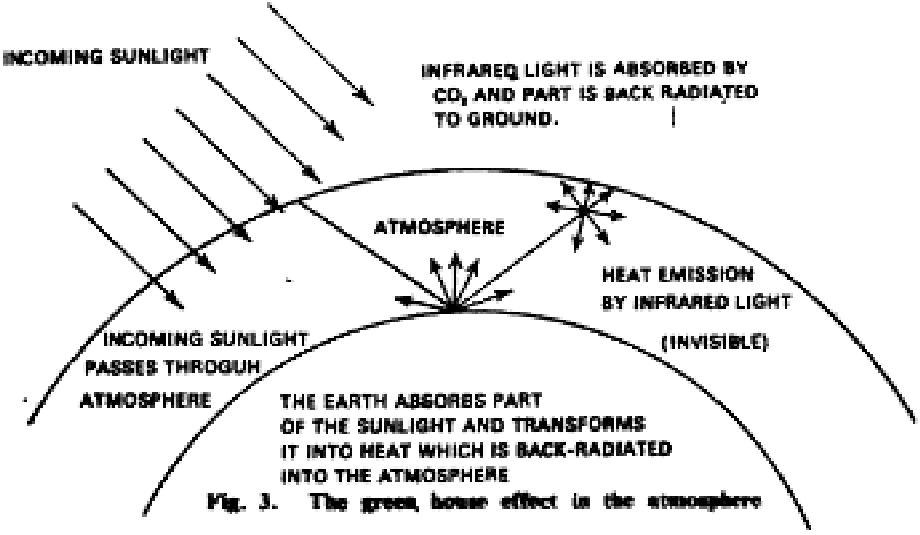
INCOMING SUNLIGHT
INFRARED LIGHT IS ABSORBED BY $CO_2$ AND PART IS BACK RADIATED TO GROUND.
ATMOSPHERE
HEAT EMISSION BY INFRARED LIGHT (INVISIBLE)
INCOMING SUNLIGHT PASSES THROGUH ATMOSPHERE
THE EARTH ABSORBS PART OF THE SUNLIGHT AND TRANSFORMS IT INTO HEAT WHICH IS BACK-RADIATED INTO THE ATMOSPHERE

Fig. 3. The green house effect in the atmosphere

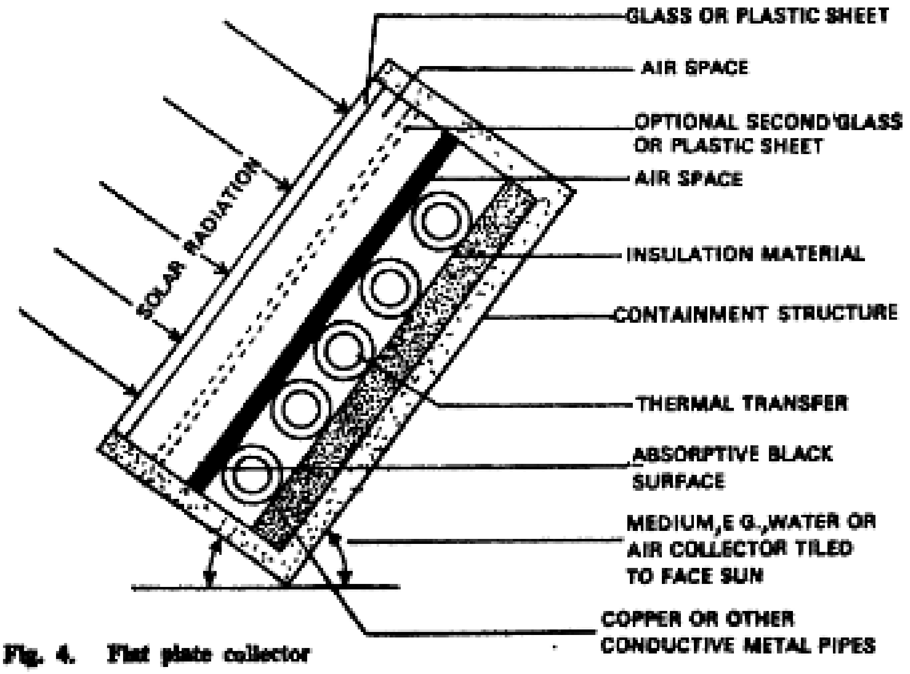

Fig. 4. Flat plate collector

20.32 cm concrete block with all of the cells grouted with cement. These walls are water-proof with plastic roofing cement and have 5.08 cm of rigid polystyrene stuck to the tar. The rear wall is rounded to provide less resistance to harsh winter winds. Temperaturein the greenhouse varies from 25.2°C to 47.6°C in winter with an average daily swing of about 16.8°C in clear weather. The living areas of the house, which are thermally isolated from the greenhouse by the adobe wall, solid corridors, and double-glazed windows, rarely fluctuate by more than 2.8°C Summer temperatures are also comfortable. The adobe wall is shaded by the roof and balcony so that it is not exposed to the summer sun and thus remains cool. A large vent in the roof at the top of the stair-wall allows warm air to escape, pulling in outside air through the doors. Typical summer temperature in the greenhouse ranges from 36.4°C to 50.4°C, with extremes at 33.6°C and 53.2°C. Living areas stay close to 40.32°C all summer.

## The greenhouse effect

The transparent glass or plastic walls and roof of the greenhouse transmit shorter wavelength 'visible light' and infrared radiation from the sun, but not the longer ones. Thus, during the hours of day infrared radiation passes into the greenhouse and warms its atmosphere and the ground on which house stands. The transparent walls and roof of the greenhouse partly reflect and partly absorb longer wavelength radiation. Subsequently, walls and roof re-emit absorbed radiation into the house. Coating of glass with a non-heat radiating film transparent to sunlight further maximizes heating effect of the radiation

Likewise, carbon dioxide and water vapour in the atmosphere transmit short wavelength solar radiation but reflect (by absorption and subsequent re-emission) the longer wavelength heat radiation from warmed surface of the earth (Fig. 3.) The rising proportion of carbon dioxide in the atmosphere, caused by large scale fossil fuel burning, is causing concern to some climatologists who assert that increase in the greenhouse effect will produce higher average surface temperatures. If this were the case, widespread climatic effects, possibly disastrous in scale, could be expected.

Flat-plate collector (Fig. 4), which makes use of the greenhouse effect, is also able to collect diffused radiation, a feature particularly important in temperate climate. The maximum temperature (also known as 'idling temperature') of the collector is that at which the losses equal the gains, and the efficiency is zero.

**Solar greenhouses—their future potential**

The solar greenhouse is a classic example of what modern technology should be doing for man; bringing him closer to his environment instead of separating him from it. The solar greenhouse is an encapsulated version of the life processes on this planet, and perhaps from this point of view man can learn to accept the earth as his solar greenhouse and become more concerned with the quality of life about him.

For a solar greenhouse no more expensive, complicated or breakdown-prone devices are required. All that needed is a good design and an active and alert person to regulate the vents, openings and natural energy flow in the dwelling. The potential is exciting—the net result will hopefully be an acceptable and economical solution to the utilisation of solar energy for space heating, greenhouses and rural residences

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# Urea inclusion complexes

UREA ($NH_2$ $CONH_2$) has the remarkable property of forming crystalline complexes with straight chain paraffinic hydrocarbons. These crystalline complexes, called inclusion complexes, consist of hollow channels formed by the crystallised urea molecules (the host) in which the straight chain hydrocarbons (guest molecules) fit in snugly. The diameter of these channels is of the order of about 5 Å, and only unbranched hydrocarbons (Fig. 1, a) find enough space to fit into the urea channel. The branched hydrocarbons (Fig. 1, b) with slightly larger dimensions do not fit into the cage and hence do not form complexes with urea. Therefore, this phenomenon offers the possibility of separating linear and branched hydrocarbons, which can be utilised for industrial extraction and refining processes in oil industry. It has been found that the presence of functional groups does not affect the capacity to form inclusion complex with urea provided that the alkyl residue linked to the functional groups has a straight chain. Thus carboxylic acids, esters, halides, ketones, alcohols, amines, etc., also form adducts with urea.

Because of the extremely high shape-selectivity of inclusion compounds subtle shape differences between molecules can be sensed down to atomic dimensions. For example, it is known that urea forms inclusion complex with dipropylfumarate; whereas dipropylmaleate does not form an adduct. (Fig. 2).

For preparation of a complex, a liquid hydrocarbon is added to a saturated aqueous solution of urea at room temperature; an adduct, if formed, separates as a voluminous crystalline precipitate. The precipitated adduct is usually pure. The hydrocarbons are usually recovered by treating the complex with water. The recovered product has a purity of 98%-99%.

Studies on the kinetics of urea adduction from aqueous solution show that the adduct is formed in the aqueous phase and not in the hydrocarbon bulk phase or at the interface (Fig. 3). Substances which change the nature of the hydrocarbon-aqueous interface (and therefore alter the rate of passage of the guest molecules from non-aqueous to aqueous phase) have profound effect on the kinetics of adduct formation. Polar additives such as alcohols or ketones improve the rate of adduction, while many soaps, hydroperoxides or sulphur compounds lower it drastically. Because these effects vary from one guest molecule to another, they may be utilised to obtain unusual selectivities.

The molar ratio of urea to hydrocarbon is determined only by the length of the latter molecule which in turn is determined by the number of carbon atoms in it. For *n*-paraffins with 6 to 17 carbon atoms, the molar ratio of the urea and hydrocarbon is given by the equation:

$$\text{moles of urea/moles of hydrocarbon} = 0.65\,n + 1.51$$

where *n* is the number of carbon atoms. This means that the host: guest molar ratio is not stoichiometric. This is because of the absence of any normal chemical bonding

$H_3C\text{-}(CH_2)_6\text{-}CH_3$

n-OCTANE

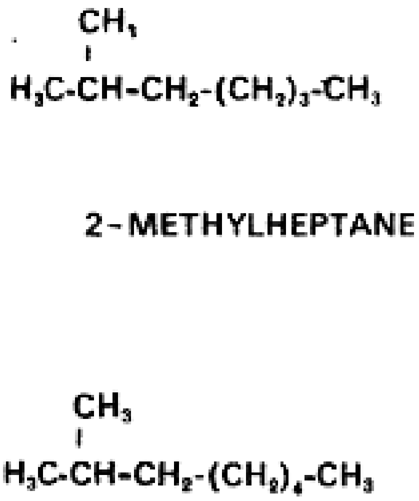
$H_3C\text{-}(CH_2)_7\text{-}CH_3$

n-NONANE

$H_3C\text{-}(CH_2)_8\text{-}CH_3$

n-DECANE

Fig. 1 (a)



$H_3C\text{-}CH(CH_3)\text{-}CH_2\text{-}(CH_2)_3\text{-}CH_3$

2-METHYLHEPTANE

$H_3C\text{-}CH(CH_3)\text{-}CH_2\text{-}(CH_2)_4\text{-}CH_3$

2-METHYLOCTANE

Fig. 1 (b)

between host urea molecules and the guest paraffin molecules.

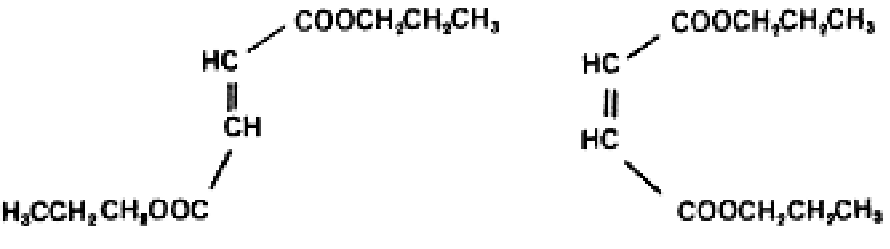
The ease of formation and stability of inclusion complexes depend upon the number of carbon atoms in the molecule. Larger the number, greater is the stability. The increasing stability of the adducts is shown by the fact that more and more heat is liberated in their formation.

In order to accelerate the rate of inclusion compound formation it is necessary to add a small amount of "activator" solvent. The activator solvent dissolves some of the host phase. The passage of the hydrocarbon from the bulk phase is thereby facilitated, and the rate of adduction increased. Ethanol, methanol, acetone and ethyl acetate are some of the activator solvents used in adduct formation.

Adduct formation using aqueous urea has been referred to earlier, the alternative method of adduct formation using solid urea is also popular. Solid urea 'wetted' with an activator is taken in a stationary column and the paraffin is passed through it. The adduct thus formed is washed with a suitable solvent and decomposed to recover the paraffin. The adduct decomposition is carried out either by treatment with water or by heating the adduct at a predetermined temperature. The decomposition temperature depends on the chain length of the guest molecule.

Although the selectivity of inclusion compound formation is very high, the separation factor for the adduction of two guests from a liquid mixture is not generally infinite. The separation may have to be repeated many times to achieve the desired product purity.

Industrial interest in urea inclusion compounds is stimulated by the fact that this remarkable shape selectivity applies to paraffinic hydrocarbons which are chemically unreactive. The technique has found maximum utility in the petroleum industry, where a rough correlation is made between quality of the product and the degree of removal of long chain paraffin molecules. For example, gasoline with large amounts of normal paraffins (*n*-pentane to *n*-decane) is no suitable as motor fuel. Such fuels are said to have low octane number and induce motor knocking which reduces the motor efficiency. Urea inculsion technique is used to selectively remove *n*-pentane to *n*-decane paraffins from such fuels to increase their octane number. Another application of urea inclusion technique is in lowering the 'pour point' of heating oil and jet fuel. Pour point is defined as the rate of flow of an oil at a particular temperature. For heating oil and jet fuel the pour point must be as low as possible. It is known that the presence of $n$-$C_{10}$ to $n$-$C_{1}$



DIPROPYLFUMARATE

DIPROPYLMALEATE

Fig. 2

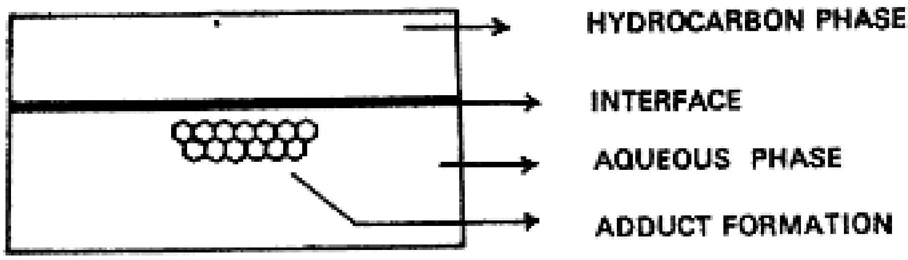


Fig. 3

paraffinic hydrocarbons reduces the rate of flow of petroleum fractions. If this petroleum fraction has to be used as heating oil or jet fuel, paraffins have to be removed to lower the pour point This can be successfully done by using the urea adduct technique.

The most important application of the technique is in the separation of pure *n*-paraffins from petroleum fractions These *n*-paraffins are useful raw materials for petrochemical products For an efficient separation of *n*-paraffins from crude petroleum, knowledge of the formation and decomposition temperatures of urea adducts of individual *n*-alkanes is essential Temperature values of the upper limit of complex formation ($\theta$) and the lower limit of decomposition ($\theta_d$) of urea complexes with *n*-alkanes can be calculated from emperial equations The temperature of the upper limit of complexation ($\theta$) is given by the equation

$$\theta = 10\ (n-4) + \gamma$$

for a single alkane component, where $n$ is the number of carbon atoms and $\gamma$ a constant depending on the activator used For example, the value of $\gamma$ is 8 for methanol and ethanol, 7 for acetone and 5 for isopropanol and ethyl acetate The temperature of the lower limit of decomposition ($\theta_d$) of the adduct is given by the equation:

$$\theta_d = 10\ (n-3) + \gamma_d$$

where $n$ is the number of carbon atoms in the molecule and $\gamma_d$ is a constant depending on the activator used during adduct formation. The value of $\gamma_d$ is 0 for methanol and isopropanol, 1 for ethanol and 10 for acetone Separation of individual alkanes from crude petroleum is done by treating the sample with urea wetted with ethanol at temperature $\theta$ (for complexing the *n*-paraffin component with the maximum number of carbon atoms) Only the specific paraffin forms the adduct while the lower carbon number paraffins are unaffected. The adduct is then washed with a suitable solvent and heated at its decomposition temperature ($\theta_d$) to recover the paraffin The unreacted petroleum fraction is again passed through urea at the adduct formation temperature of the paraffin of the next lower carbon number By repeating this process all the individual paraffins can be separated.

The phenomenon of urea inclusion complexes has attracted a lot of scientific attention and considerable amount of work has been done to understand fully different aspects of this phenomenon In petroleum industry this technique has been used with considerable success.

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# Textiles can catch criminals

A CRIMINAL with all his intelligence cannot take care of every possible clue to detection and is likely to leave his finger, foot or shoe print, handkerchief, clothes, blood or hair at the scene of the crime It is possible to trace the culprits from these clues There are not many articles that afford as many clues to the personality, habits and history of the owner as clothes. Fibres and fabrics are always present, in one form or the other, whenever a crime takes place Evidence provided by them may be very convincing and conclusive in many criminal cases Recognition of their nature may establish the innocence or guilt of a suspected person. Ash of textile fibres is also helpful in crime detection

Textile fibres are classified into two groups—natural and man-made, of which the latter can further be grouped as regenerated cellulosic fibres and synthetic fibres. The important natural fibres are cotton, jute, wool, hemp and silk. Viscose and acetate fibres belong to the class of regenerated cellulosic fibres There may be more than a hundred varieties of synthetic fibres but the more important and widely used types are polyester (Terylene), polyamide (Nylon), polyacrylonitrile (Acrylic) and polyolefine (Polythene).

**How are fibres identified?**

There are a number of methods for identifying textile fibres of which the quick and reliable ones are

(a) microscopical examination; (b) burning test; (c) staining test; and (d) solubility in different solvents.

For microscopical examination of fibres, any good microscope with an intermediate magnification range (300 to 400) may be used. Certainty of recognition by microscope can be attained only by long experience. In the longitudinal view unmercerized cotton fibres appear twisted, wool fibres show a scaly structure, viscose, acetate and acrylic fibres have serrations, while mercerized cotton fibres, silk, polyester and polyamides have a smooth surface. Cross-sectional view provides more information than longitudinal view in some cases but a skilled operator is required to cut good cross-sections and also a large number of fibres should be available for study, which is not possible in many cases The published standard illustrations of the structure of fibres should only be considered as guidelines.

Infrared spectrophotometry, X-ray diffractometry, UV spectrophotometry, NMR spectroscopy and electron microscopy are the techniques which can confirm these tests. Presence of dyes, resins, optical brightners and other chemicals present on the fibres can also be detected by these instruments.

## Garments and fabrics

Garments and fabrics are very helpful in criminal investigations because they possess excellent absorbing and retaining (of smells, liquids and solids) property. The various aspects under which clothes may be studied are: the nature of fibre(s); the colour; the method of weaving; the number of threads/centimeter in warp (lengthwise) and weft (widthwise); twist direction and twist per cm of warp and weft yarn; holes or repairs; torn out parts; tailor's name or mark; any inscription on the buttons; nature and condition of the lining, contents of pockets (common articles, dust and dirt); stoins and other marks; and paint, oil, soil, grease and foreign matter found on them. The age of garments is equally important and can be judged from their condition as regards wear and tear and from their colour (for example, fresh or faded). In case of murder in which the body and clothes are duly buried, one can estimate the length of time of burial from the state of decay of clothes which, in turn,depends upon nature of the material, nature of soil depth of burial and dampness of the soil. Clothes must be sent immediately to the laboratory and carefully examined in detail.

In the case of stain and holes, their position, size and general appearance should be recorded. Normally, their close-up photographs are taken. Sometimes, the shape of even small stain has special significance. Commonsense, however, plays the vital role in such interpretations.

## Examination

Before conducting chemical analysis of stains the stained portion should be thoroughly examined under a miscroscope and, if possible, by using ultraviolet rays as certain stains give characteristic fluorescence. A spectroscopic examination of the ash of stained cloth may provide valuable information A part of the stained portion should be cut out, leaving behind the remaining portion for subsequent reference and further examination if required. The material that has produced stains should be dissolved in an appropriate solvent by soaking the cut piece in it. A control specimen should also be prepared with unstained portion of the cloth.

*Acid stains.* The acid stains on clothes and the holes so made are useful evidence in connection with crimes of acid throwing, making of explosives and forgery of bank notes or other valuable documents. Sulphuric acid acts vigorously on cotton, viscose and linen. On woolen fabrics, the action is less pronounced while synthetic garments are the least affected. Nitric acid is not as destructive as sulphuric acid. Hydrochloric acid harms the clothes least. Sulphuric acid produces on clothes red or reddish-brown stains, nitric acid brown, and hydrochoric acid yellow or greenish-yellow. The easiest test to determine the presence of acid is to press a moistened blue litmus paper against the spot which turns red.

*Oil and grease stains.* Generally such stains are clearly visible, but if the stain is small and the clothes are dark coloured or dirty, they may escape notice. These stains can be detected by placing the garment between several layers of tissue paper or blotting paper and ironing with a hot iron. The best solvent for oil and grease is ether or petrol.

*Vomit stains.* Stains of vomit, faeces and urine on clothing or bed clothes are of importance in cases of poisoning. One can find out the kind of poison from these stains.

*Other miscellaneous stains.* These may be caused by blood, chemicals, dye, fruit juice, paint, rust, ink, wine and many other substances, each of which requires a different method of treatment. Normal saline can easily bring out the oldest blood stain. Under ultraviolet light seminal fluids are markedly fluorescent.

*Holes or bullet marks.* In order to carry out chemical tests, small portions of the cloth round the the should be cut without destroying hole and soaked in distilled water. In fact, the material available for such tests is so small that use of microchemical or spectroscopic analysis becomes inevitable. For the spectroscopic test, ash of the cut-out cloth should be tested. Control tests should also be carried out. Bullets generally leave residue of alkaline nature, lead, potassium, mercury, nitrate and sulphate around the hole. Sometimes the shot hole is surrounded by a narrow black zone which may be due to smoke, powder residue or dirt or grease from the projectile.

*Dust and dirt*. The dust and dirt from pockets provide valuable information. The best way of examining them is to cut the stitches at the seam and open out the pockets on a large sheet of paper and collect the dust by means of a clean brush. From other places of garment dust or dirt can be removed with the help of a small vacuum cleaner or by putting the garment in a strong and clean paper bag and then beating with a stick. Anything so obtained should be carefully examined under a magnifying glass and the details recorded.

*Textile ash*. Textile fibres when burnt are converted into definite structures. This behaviour is taken advantage of in forensic investigations. Analysis of ash may be helpful in cases of settling the claims for compensation of the insured textile goods, investigation of murder in which the dead body is burnt alongwith the clothing, arson, etc.

*Finger and footprints*. Of all the known techniques, finger and foot print analysis is probably the most important. It is now possible to collect finger prints from fabric or plastic surfaces. In one of the techniques, the fabric is exposed to a radioactive gas (Bromine 82 or Gold-Cadmium vapour or Sulphur dioxide, etc.) which will sensitize the print and subsequently the radiograph can be taken.

A clear set of footprints can be obtained by spraying polythene powder over the carpet. The powder will stick preferentially to the areas which are electrically charged. One should note that an electrical charge on a carpet develops precisely over the area where the foot has pressed it. This technique is useful only if the investigator reaches the scene of the crime within one or two hours, as the electrical charge decays rapidly.

Although with a large number of fibres and a variety of treatments given to them it is often difficult today to provide accurate or precise predictions, the help of latest instruments and analytical techniques may certainly be able to identify all fibres in the near future.

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# Wheat rusts

WHEAT in India is generally cultivated as a winter crop. In the plains and south Indian plateau normally it is sown in late October or November and harvested in March and April. In south India, the crop matures by February end or early March but in northern plains maturity occurs between last week of March and middle of April. In Nilgiri and Palani hills of south India, two wheat crops are taken simultaneously, viz., the winter crop is sown in October/November and harvested in May and the next crop is sown in June and harvested in September. In the Northern hills, sowing is done a bit earlier than in the plains and the crop generally matures by May except at high altitudes (2100m-2400m) where the maturity is attained by June.

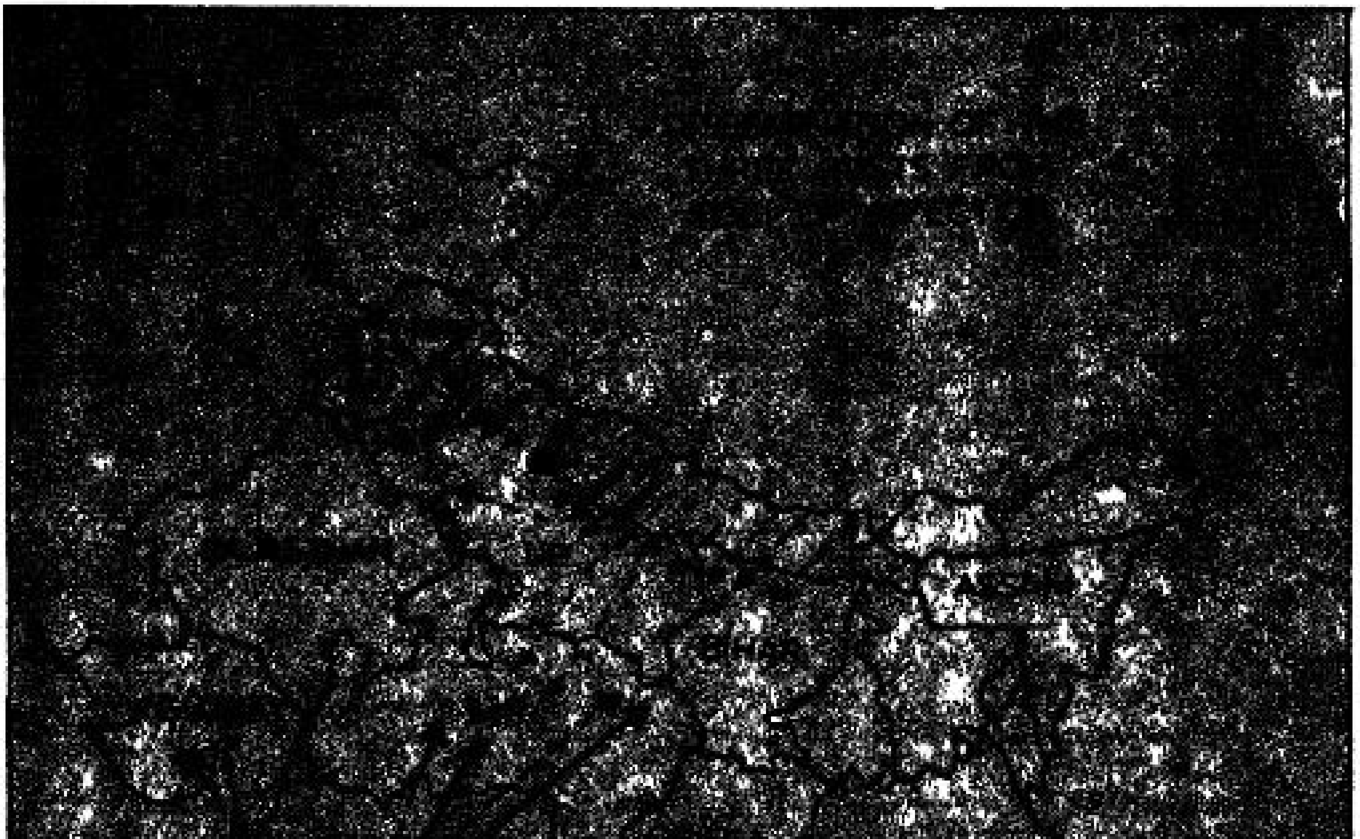
One of the most dreaded diseases of wheat crop in India is the 'wheat rust'. Estimates of annual losses due to wheat rust vary widely according to various authors They range from Rs. 40 million to Rs. 392 millions.

Wheat rusts are caused by three different species of fungus *Puccinia* which exhibit characteristic features of plants. These are termed: Stem/Black rust (caused by *Puccinia graminis tritici*). Leaf/Brown rust (caused by *P. recondita*) and Stripe/Yellow rust is essentially a problem of North-West India. Brown rust occurs in every part of the country where wheat is cultivated whereas black rust mainly affects crops in Central India.

## Life-cycle of Fungi

The three species of fungi associated with wheat rust diseases have very complex life cycle and have as many as five spore stages, namely, uredospore, teleutospore, basidiospore, pycnidiospore and aeciospore. But in India as the alternate hosts (Berberris and Thalictrum spp.) are not active, only uredospore and teleutospore which are asexual spore stages occur.

The brown, deep brown or yellow stage commonly seen on wheat plant is uredial stage and as the plant begins to mature in the field, the pustules in which uredospores were earlier produced begin to produce teleutospores and turn black. Actually at later stages all the three rusts—black, brown and yellow—turn black in appearance due to teleutospore formation. The uredospores are transported by wind currents to new areas where they re-establish infection in the normal wheat crop. It is the uredospore stage which is infective and causes secondary infection. The rust spore (uredospores) inoculum development is a polycyclic (repeated cycles



*Life cycle of stem rust as it occurs in Indian subcontinent.* **Teleutosphore infects *Berberis* Spp. but this alternate host is not active in India**

in succession) phenomenon and a single cycle takes about 7 days. With the advancement of the season from winter to summer the temperature starts rising and uredospores get converted into teleutospores. These spores do not survive at temperatures more than 30°C, which is normally the temperature of plains in the month of April.

It has been shown that there is no local source of infection as such in the plains from one season to next. On the other hand, rusts survive in the hills as uredospores on self-sown plants, ratoon tillers, and in some cases, on regular summer crop in the hills. Every year rust spores are blown down from the hills to plains where they re-establish infection in normal wheat crop.

## Spread (dissemination) of wheat rusts

In India, considerable amount of work on wheat rust was done by late K. C. Mehta of Agra College. He was the first to initiate studies on epidemiology of wheat rusts. He carried out studies on physiologic races, alternate hosts and the occurrence of rusts. His studies proved that *Berberis* spp. occurring in the hills of India do not have any role to play in annual recurrence of black rust in plains, but that the rust spreads from central Nepal to the northern Indian plains and from Nilgiris to the southern wheat growing zone. He concluded that the Himalayas in the north and Nilgiris and Palani hills in the south are the chief foci of rust infection. But L. M. Joshi and collegues at I.A.R.I. in 1974 pointed out that black rust develops at an early date in south India which then serves as inoculum reservoir for rest of the country.

Brown rust of wheat has clearly two foci of infection, the Himalayas in the North, and Nilgiris and Palani hills in the South. It is the most widely prevalent rust. The uredospores get transported by upper winds from Nilgiris and Palani hills and then are washed down over Central India by rains. The Northern infection moves slowly southwards until the two populations merge (see map).

The air-borne inoculum of brown rust as well as black rust and its deposition from Southern hills has been traced by wind trajectories and weather satellite cloud images. From recent investigations (Nagarajan and Singh, 1975) it appears that the tropical cyclones have a great bearing on the deposition of spores in central India within a time-span of about 70 hours. The cyclonic disturbances occurring in the Bay of Bengal/Arabian Sea in late October or early November set a pattern of favourable winds which carry the inoculum of black and brown rusts (see map) from Southern foci to the target area in Madhya Pradesh along with rain clouds. It has been found that the invisible spore cloud movement can be successfully tagged with the visible cloud movements seen in satellite television cloud photographs. This method has shown that the uredospores are transported from Nilgiris by upper air wind and are deposited over Central India along with rain. From these secondary foci, it spreads to other foci making a nation-wide appearance.

Yellow rust is restricted in its distribution and appearance in epidemic form only to north western regions. Normally, the rust appears in the foot-hills and plains in December or first fortnight of January, when condition in plains is quite favourable and rapid multiplication of inoculum takes place. By the end of February or beginning of March, the temperature begins to rise and the further spread of rust stops.

## Control measures

Various methods have been suggested from time to time for the control of wheat rust diseases. They include sowing of resistant varieties and chemical sprays. When the disease can be controlled easily by less expensive chemicals, use of such chemicals is advocated. By and large, breeding for disease resistance is the most effective method to control rust. Varieties like HD 2009, HD 2204, HD 2135, HD 2278 and 2281, Sonalika, WH 147 are resistant to rust upto some extent. But extremely late sowing in northern India and early sowing in central India should be avoided as late sown crop is much affected by brown rust and early one by black rust.

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# *Parthenium hysterophorus*

*Parthenium hysterophorus* (compositae) an exotic weed, though a native of West Indies, Central and North America, has been observed to grow abundantly in many states in India where it is known by several names such as Chetak Chandani, Gajra Grass and Phandaphuli. The weed is playing havoc with various crops, particularly wheat. It has also been reported to cause many allergic diseases such as hay fever, asthma and dermatitis. However, its medicinal applications . to reduce fever and neuralgic pain, to stimulate menstrual function and in the treatment of dysentery, deserve thorough study. We have carried out the chemical investigation of its essential oil (yield, 0.02%), obtained by steam distillation of the plant, and isolated rotunol, carveol, α-cyperone and n-tridecane. Further studies are in progress.

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ENCYCLOPEDIA OF WATER POLLUTION IN INDIA

**WATER POLLUTION**

**(Principles of disinfection of drinking water and its analysis)**

*By*

**Dr. V. P. KUDESIA, Ph. D., D. Sc., P.D.F. (Belgium)**

This is a very timely publication from an expert in the field of Water Pollution and Public Health Engineering with a credit of 150 research papers in India and abroad. This book covers the fields of Public Health Engineering, Sanitary Engineering, Industrial toxicology, Clinical toxicology, Forensic toxicology, Fisheries biology with special emphasis on chemical analysis of water and waste water, chemical kinetics, instrumental techniques and pesticides. Some new theories have been proposed for the better and effective disinfection of drinking water and improvement of sanitary facilities.

It will be of immense help to biochemists, environmental biologists, Public Health engineers, chemical engineers, sanitary engineers and applied chemists for the better benefit of human life in our country

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# NEWS & NOTES

*Interview*

## Dr. M.K. Chandrashekaran —Bhatnagar

### Award winner

"TODAY I feel proud of getting the Bhatnagar Award " says Dr M K Chandrashekaran, of the School of Biological Sciences Madurai Kamaraj University, Madurai, "not so much for the number of papers I have published but because the subject of my research was laughed at when I begun research in it as a young man Dr Chandrashekaran s field of research is Biochronology or Biological clocks His interest in this field was aroused when he discovered way back in 1960 by sheer chance the tidal rhythm in an inter tidal mole crab near his laboratory in the sea coast of Madras. "The results were so clear " said he enthusiastically that my crabs were writing their own stories on smoked drums without I being aware of it " He found that the crab swam actively when the sea rose and remained nearly motionless six hours later when the sea ebbed He subsequently found tidal as well as diurnal rhythms in the swimming and oxygen uptake of the crab

However in those early sixties, the subject of biological clocks was as respectable in India as palmistry, astrology and the like People used to laugh at him when Dr Chandrashekaran used to reveal his subject of research They used to say "Oh! Clocks! Lunar clocks! Solar clocks! Biological clocks? " For a young man with budding interest in the subject, he told me, it was indeed a "shattering " experience, but, then, he had the courage of his convictions He stuck to his subject Many times he felt that he should pursue a subject like fisheries, forestry agriculture, which would directly benefit the country rather than the abstract pursuits of biochronology that he had taken up But no his mind did not allow him that He decided to leave the country rather than the "first class subject of biochronology

Dr M K. Chandrashekaran the 1979 S S Bhatnagar Awardee for Biological Sciences He shares the Award with Prof Amar Nath Bhaduri

So for almost a decade between 1965 and 75 Dr Chandrashekaran had been abroad working under Dr H c E Buenning of the University of Tuebingen West Germany, who is one of the father figures of biological rhythm research During this entire period he carried out detailed researches on the biological clocks of *Drosophila pseudoobscura*, a fruit fly However, the desire to serve his country was always uppermost in his mind, and when the first opportunity came he took it Against his German colleagues wishes he came to India when there were still three years left for his scholarship to expire T anks to his efforts he has today his own separate department on biochronology at the Madurai Kamaraj University Besides teaching biochronology as a subject, about 13 students are doing research under him Today, he can easily be called as the poneer of biochronology in India

In his last 20 years of research Dr Chandrashekaran has carried on researches on various facets of biological clocks he has not only given his own theories but has also provided experimental proofs for the theories of other biochronologists At present he is working on various characteristics of the biological clocks of bats, squirrels and cotton plants One of the interesting things he and his group has recently discovered is the connection between pathogenicity and biological clock of cotton plant His group has shown that endotoxin, which is produced by a pathogen, affects the bioclock of cotton plant

A broad-shouldered hefty person Dr Chandrasekharan is a keen student of English literature but often quotes Sanskrit words while speakking He also writes occasionally in newspapers and science magazines on various topics and is keen to develop this art Always busy with his researches in caves and laboratory, he feels, he told me, nervous in a crowd as he was then when I talked to him after the presentation ceremony of the Bhatnagar Awards at New Delhi

DILIP M SALWI

# IPPTA Seminar

THE two-day zonal seminar of the Indian Pulp and Paper Technical Association was held at the Forest Research Institute and Colleges, Dehra Dun on 20 and 21 September, 1980. About 20 research papers were submitted by various Institutions, Laboratories and Paper Mills. Some technologists from abroad who were on tour to India also participated in the seminar.

The subjects of the seminar was 'High yield pulping' and 'Bleaching of pulp'. The IPPTA President, N. Ravindranathan said that when forest-based raw materials are fast dwindling due to various reasons, high yield pulping is the surest way to conserve this valuable raw material for the survival of our paper industry. He asserted that even though the technology in high yield pulping has made tremendous progress, paper industry in India is yet to utilize this advanced method of pulping on a commercial scale. He also said about the importance of bleaching of pulp, where careful controls are needed not to reduce the strength of paper and wastage of chemicals in the process. J. C. Aggarwal, a founder member of IPPTA, in his keynote address made a forceful plea for increased production through process of high yield from low capital investment. A. S. Alwan, FAO representative to India addressed on 'A new applied research centre for the Indian pulp and paper industry'.

It is well-known that the Indian pulp and paper industry is now facing new challenges at every step. The country is crippled with an acute shortage of paper and confronted with an ever increasing demand. Under such circumstances, a seminar of this kind can be really rewarding. The Executive Secretary of the Association said that total paper production during the last financial year was around one million tonnes. This year the production is expected to touch the level of 1.2 million tonnes. The annual demand however is estimated to be around three million tonnes. This very well calls for intensive research and training programmes suited to India's raw materials. A. R. K. Rao, Project Coordinator of a Pilot Project jointly sponsored by UNDP, FAO, Government of India and others said that some of the experiments and findings may enable the scientists to evolve a much more productive system giving much more finished product out of the same quantity of raw materials. He said that although the pilot projects are having trial runs now, by another six months these will be completely operative. The seminar was concluded after discussions on the needs and potentials in the fields of paper industry especially in respect of raw materials availability, its pulping system and the implementation of latest advanced technology.

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# International symposium on solar eclipse

ON the invitation of the Indian National Science Academy, a large number of optical astronomers, radio astronomers, ionospheric physicists and biologists from various countries visited India on the occasion of Total Solar Eclipse on 16th February 1980 to observe and undertake experiments. Many successful experiments were conducted during this event both by Indian and foreign scientists.

The Indian National Science Academy is organising an International Symposium on Solar Eclipse from 27th to 31st January 1981 for discussing the results obtained during this eclipse in India in order to compare the results with measurements made elsewhere in the world and to interpret the results in the light of present and past measurements.

The major objective of the symposium is to emphasise an interdisciplinary aspect of the measurements.

The following are the main areas in which the papers will be accepted: (1) Optical and Radio Astronomy; (2) Ionospheric Physics and Aeronomy; (3) Atmospheric Physics and Atmospheric. Electrodynamics; (4) Geomagnetism ;(5) Radiation and Life Processes.

The symposium will be held at the Indian National Science Academy, 1, Bahadur Shah Zafar Marg, New Delhi-110002.

## MEDICAL NOTES

# Garlic—an effective antimicrobial bulb

GARLIC (*lasun* or *lahsun*), botanically known as *Allium sativum* L. is widely distributed all over the world. In addition to being used as a spice, it is well known as a popular folk medicine The medicinal use of garlic has its origin in antiquity. It developed on the basis of long experience and has been maintained through limited ancient literature and folklores.

In ancient Indian medical literature (*Sushrut Samhita*), garlic has been documented as a curative agent for numerous diseases, viz, haemorrhoids, rheumatism, dermatitis, abdominal pain, cough, loss of appetite, loss of weight, leprosy, parasitic infestations and pyrexia. Also, in ancient Egypt garlic was supplied in the diets of workers during the construction of pyramids of King Khufu so as to maintain their vigour. Greek physician, Hippocrates, known as father of medicine, described in his writings the unique medical effects of garlic, especially for wounds, toothaches, leprosy, epilepsy and pains in the chest.

The detailed description of garlic as a medicinal plant was also given by Dioscorides in *de Materia Medica* (first century A.D.) wherein it is recommended as a vermifuge and diuretic as well as remedy for skin rashes, parasitic infestation, birth marks, and snake and dog bites. It was already well-known in Germany before the conquest of Gaul and Germania by the Romans and was used by a large section of population as food, spice and folk medicine. The famous herbal doctors Paracelcus and Lonicerus (1564) emphasized the antitoxic properties of garlic. Besides, its value against intestinal worms was also recognized by the latter Mathiolus in his *New Kreuter buch* published in 1626 recommended the use of garlic for a variety of disorders including stomach chills, flatulence and colics, etc

Dynamic quality of garlic as an invigorating and therapeutic drug has been known since ancient times However, its use has been empirical rather than based on sound scientific rationale To provide scientific basis for the medicinal use of garlic, researchers have carried out investigations on it The cholesterol reducing, blood sugar reducing and antiatherosclerotic activities of garlic have already been well documented. Although the antimicorbial property of garlic was demonstrated by Louis Pasteur in the year 1858, the observations did not receive due recognition. Furthermore, subsequent to the discovery of penicillin and other antibiotics exploration of higher plants for their antimicrobial activity remained ignored.

However, massive and indiscriminate use of antibiotics, both as therapeutic agents and feed additives, has posed serious problems of drug resistance (organisms insensitive to antibiotics) and drug allergy (sensitivity of individuals to antibiotics). Further, the exorbitant cost of antibiotics limits their use, particularly in veterinary practice. Eventually, though late, higher flora again attracted the scientists and have been explored for their antimicrobial activity.

Raw garlic has been found to possess a strong broad spectrum antibacterial property. Our laboratory

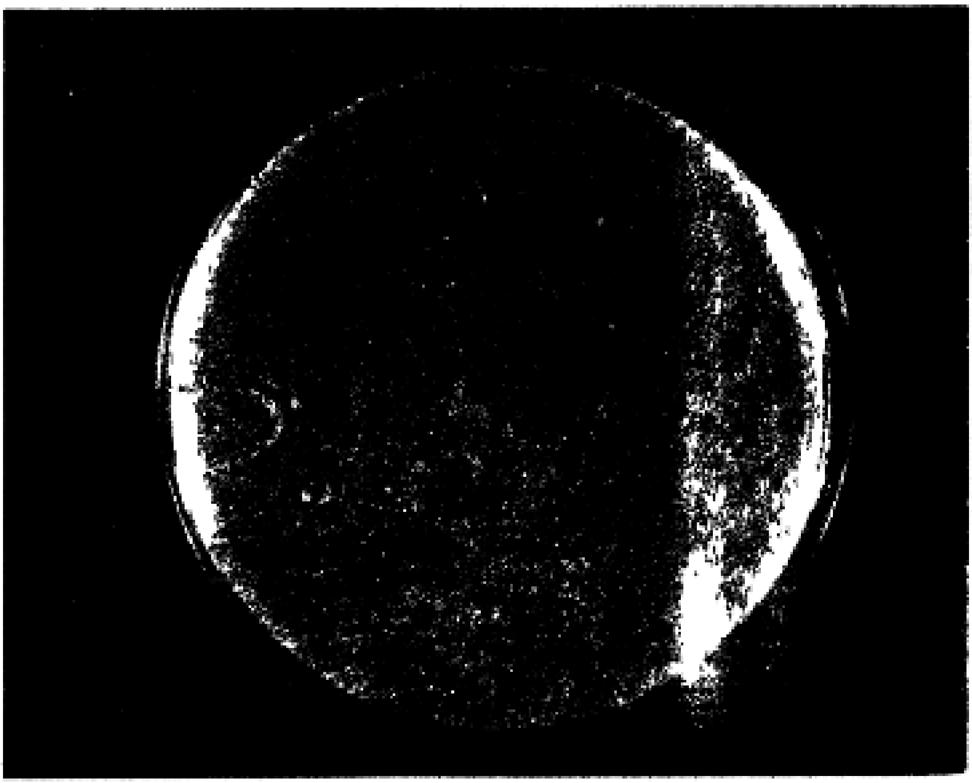


Fig. 1. *A sativum* extract ($A_1$) inhibited the growth of *Proteus* sp. resistant to all the 12 antibiotics tested. Heat treatment at 100°C for 5 min inactivated the antibacterial property of the extract ($A_2$)

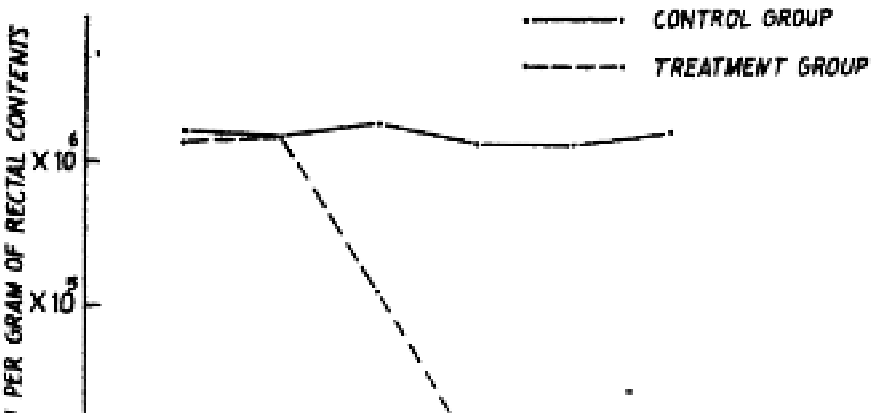


Fig. 2. Effect of Garlic Extract on Gram-negative bacilli of the intestinal tract of poultry

investigations indicated that crude aqueous extract of garlic markedly inhibited the growth of a wide variety of bacteria including those causing diseases in man and animals. It is noteworthy that some of the bacteria resistant to the commonly used chemotherapeutic agents were found sensitive to garlic extract (Fig 1). The oral administration of garlic extract resulted in a significant decrease in the intestinal bacterial load of poultry (Sharma *et al.* 1977) (Fig. 2.) Crude extract and powder of garlic have been found to be effective against the causative agents of cholera, typhoid, tuberculosis and dysentery In Russia garlic extract is used as an antibiotic and is known as Russian penicillin

The work carried out in our laboratory also revealed that garlic possesses a broad spectrum antifungal activity against a variety of fungi including pathogens, common contaminants and toxigenic ones Its aqueous extract is fungicidal in higher concentrations, whereas in lower concentrations it inhibits the growth of fungi Some fungi were found to be more sensitive than others The fungi causing ringworm (*Trichophyton* and *Microsporum* sp.), vaginitis, mastitis and muco-cutaneous infections (*Candida* sp ) and nasal infections and meningitis (*Cryptococcus* sp ) were found quite sensitive to its extract

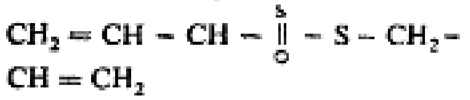
In our laboratory, the incorporation of garlic (3%) in poultry feed concentrate inhibited the growth of disease producing (*Candida albicans* and *Aspergillus fumigatus*) as well as aflatoxin producing (*A parasiticus*) fungi It indicates that garlic can be considered a promising antifungal feed additive which is effective against bacteria and fungi The authors also observed that the raw garlic chips in as low as 3% concentration (w/w) incorporated in poultry feed not only protected the chicks against experimental infection of *Candida albicans*, but also relieved the affected chicks from the disease Observations suggest that garlic can be used for prevention as well as treatment of poultry candidiasis a common mycotic disease (Prasad, 1979)

The topical application of garlic in ringworm cases has yielded encouraging results The findings of Medical College, Changsha, appeared in February '80 issue of *Chinese Medical Journal* indicate that cryptococcal meningitis, which is frequently fatal, can be treated with garlic successfully without any side effect It is worth mentioning that the drugs available for the treatment of cryptococcal meningitis and candidiasis are quite toxic

Antifungal activity of garlic extract has also been investigated against plant pathogens and soil fungi The crude aqueous extract of garlic, has been used for control of a few plant diseases of fungal origin like rust

In addition to antibacterial and antifungal activity of garlic, antiviral and antitumor properties have also been reported It is quite effective against influenza virus $A_2$ and B in chicken embryos Garlic has also been found to possess anthelmintic, antiprotozoan as well as insecticidal. properties.

Limited attempts have been made to isolate active principle of garlic or to elucidate the possible mechanism of its action Allicin, which is considered to be the active principle of garlic, is chemically known as diallyl disulfide (Fig. 3).



$$CH_2 = CH - CH - \overset{S}{\underset{O}{\|}} - S - CH_2 - CH = CH_2$$

The characteristic odour of garlic is believed to be due to allicin It is liberated when cells of the bulb are ruptured, because the enzyme which converts alliin (precursor of allicin) into allicin is not active in intact cells Besides allicin, other active components have also been isolated and named differently by other workers such as allisatin I, allisatin II. garlicin and garlic phytoncides, etc It is still enigmatic whether these components are nothing but allicin. The mechanism of action of allicin has not thoroughly been worked out It has been hyphothesized that $-\overset{S}{\underset{O}{\|}}-S-$ group is responsible for its antimicrobial property.

The authors have found that the antimicrobial activity of crude extract of garlic is heat labile and is lost completely on boiling for five minutes (Fig. 1). Garlic in cooked foods obviously contains no antimicrobial effect. Also, at room temperature gradual loss in the activity was recorded upto eight days when it became completely ineffective.

Therefore, on the basis of literature available, raw garlic extract can be considered a potent antibacterial, antifungal, antiparasitic and possibly antiviral agent Although only limited work has so far been done on its therapeutic efficacy against infectious diseases, it appears to be quite effective against fungal and bacterial infections, specially those affecting gastrointestinal tract and skin To make garlic therapy a practice, further scientific explorations are needed.

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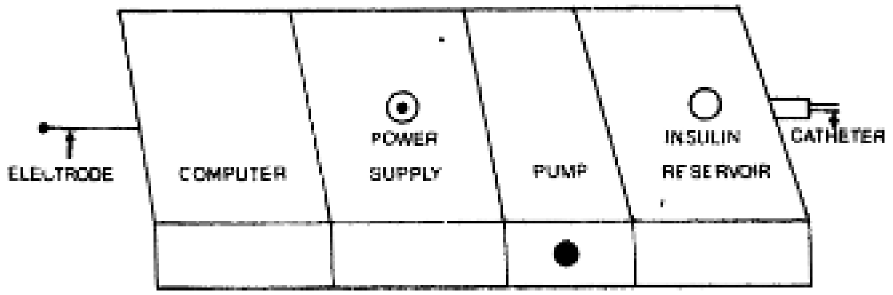
# Artificial pancreas

THE pancreas is a secretory gland of higher organisms including man and is known to secrete at least five hormones. One of them is insulin which is mainly responsible for controlling the utilization of sugar (glucose) in the body. The deficiency of this hormone, either relative or absolute, leads to an increase in blood glucose level (hyperglycaemia) and glucose is passed in the urine (glycosuria). This condition is known as diabetes mellitus. The disease can be controlled by oral drugs which either increase the secretion of insulin from the pancreas or increase the utilization of glucose as in insulin independent diabetic patients. It can also be controlled by giving exogenous insulin (insulin injections) to the patient.

There are certain forms of this disease which are difficult to control, viz., (1) Brittle diabetes or unstable diabetes in which the blood glucose fluctuates to very high or very low levels, (2) Insulin resistant diabetes in which patients develop insulin antibodies due to repeated injections of insulin, and (3) Diabetes with complications of blood vessels in which body organs such as eyes, heart and kidneys are involved. To control such forms of the disease new methods are being developed. One such recent innovation is the development of artificial pancreas.

Artificial pancreas (also known as artificial beta cell after the cells of islets of Langerhans of pancreas which secrete insulin) is an electronic device Its working principle is quite simple It constantly monitors the blood glucose level and can infuse either insulin or glucose depending upon the glucose level in the blood.

The first report of the development of this machine came in 1973 simultaneously from two groups of workers. One group (A. M. Albisser, B.S. Leibel, T.G. Ewart, Z. Davidovac, C K Botz, and W. Zingg, Department of Medical Engineering



IMPLANTABLE ARTIFICIAL PANCREAS

[illegible] Banting and Best Department of Medical Research and Institute of Medical Sciences, University of Toronto, and Department of Rehabilitation Medicine, Wellesley Hospital, Toronto, Canada) reported the development of a big machine which was devised to deliver insulin or glucose continuously and establish normal glucose level in the blood. This is a machine of the size of a television set and is used by the bedside of the patient. A mini computer is programmed to respond to the constantly monitored blood glucose level by injecting appropriate insulin or glucose intravenously to maintain or restore the normal blood sugar.

The other group (K. W. Chang, S. Aisenberg, J. S. Soelender, and J. M. Hiebert, Joslin Diabetes Foundation, Boston, U.S.A.) reported the development of a mini pancreas which is also called glucose sensor. This is a very small device which can be implanted under the subcutaneous [illegible] automatically injects the hormone. A portable model of the mini pancreas is also available (*J. American Med. Assoc.* Jan. 19, 1979).

The latest model of the mini artificial pancreas consists of a glucose sensing electrode, power source, computer, insulin reservoir and pump, all contained in a package the size of a cigarette pack. The sensor is based on the platinum catalyzed oxidation of glucose. In the presence of glucose a chemical reaction occurs on the surface of the electrode by which electrons are liberated. The higher the concentration of glucose, the more electrons are freed. The computer then measures the electric current generated and determines the blood glucose concentration. The pump consists of two chambers, separated by flexible metal bellows. The device is powered by vapour pressure from a fluorocarbon that boils at body temperature pushing the bellows and pumping the insulin. The flow rate is set by a length of capillary [illegible] a delivery [illegible] that [illegible] vein of the patient. The fluoro[illegible] power source is easily refilled [illegible] means of a needle through a [illegible] sealing septum in the pump. The mini artificial pancreas has two infusion rates. There is a basal infusion rate which is normally maintained. At meal time when the patient needs more insulin a magnet is passed over the skin above the implanted pump. This magnet opens a valve so that the insulin infusion rate is increased.

Studies carried out so far have shown that blood glucose levels in unstable diabetics can be normalised and the equipment can be used in emergency situations such as diabetic coma, ketoacidosis, post, pre and intraoperative care of diabetics.

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# SCIENCE FOR THE YOUNG

## Brain teasers

**Big Square—small square**

1. A small square and a big square are arranged in the way shown in Fig. 1. Point O is the centre of the small circle. The side AC of the small square is trisected at point B or AB=1/3 AC. Given that the side AC is 6 cms. What is the area of the shaded portion?

**Test your logic**

2. Mr. A, Mr. B and Mr. C are very good logicians. There are four red stamps and four green stamps and two stamps are to be pasted on each one's forehead. They are blindfolded and the stamps are pasted. When their blindfolds are removed Mr. A was asked if he knew the colour of stamps on his head. Mr. A replied in negative, Similarly Mr. B and Mr. C replied in negative when asked about the colour of stamps on their forehead. In the second round of questioning Mr. A again could not tell the answer. But Mr. B, when asked, told the correct answer. How did he do it?

Bhupesh Mangla
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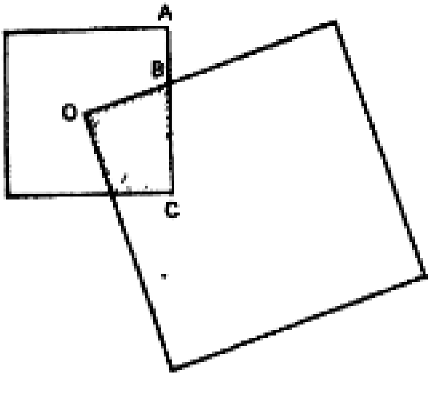

Fig. 1

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## They flavour our food

THE ancient Egyptians used cinnamon and cassia as spices obtained from the Arabs who, in turn, obtained them from the Indians.

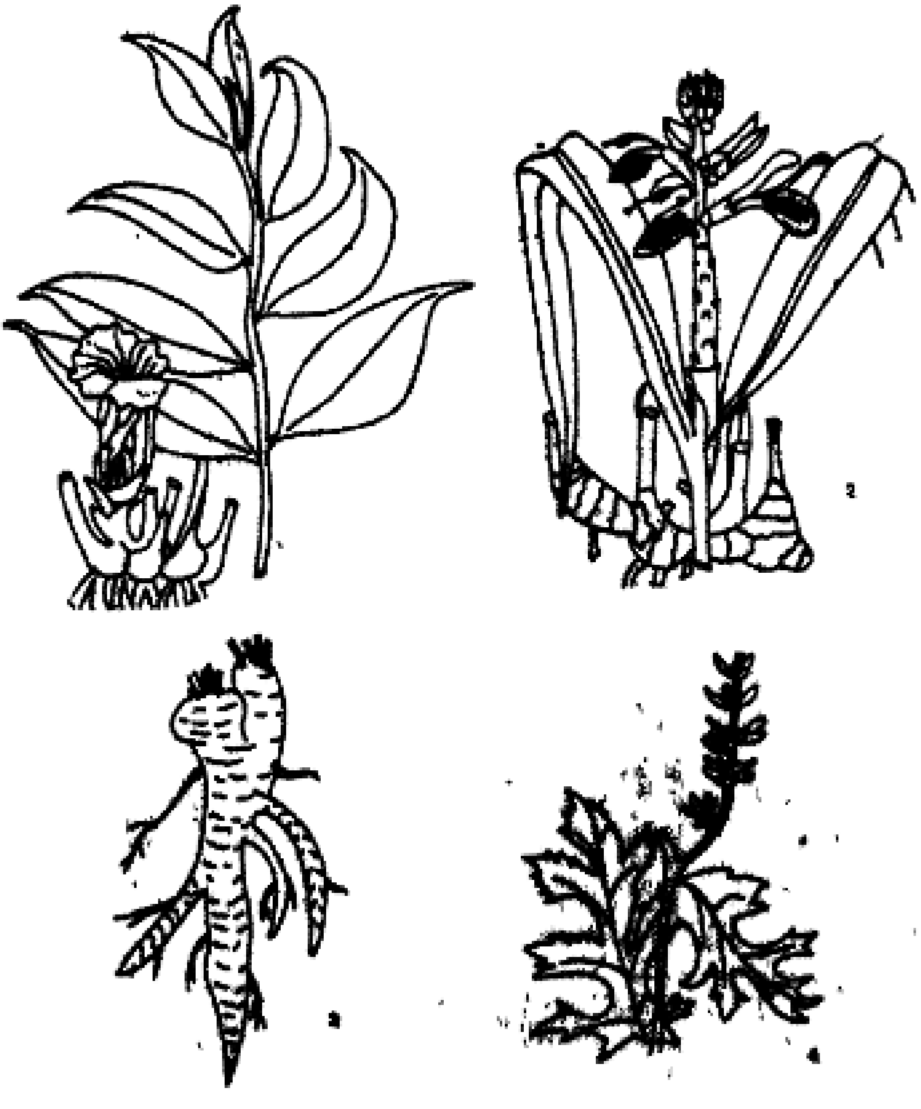


**Fig. 1-4.** *Aframomum meleguata.* (1), *Alpinia officinarum* (2), *Aronoraria rusticana* (3) *Artemisia vulgaris* (4)

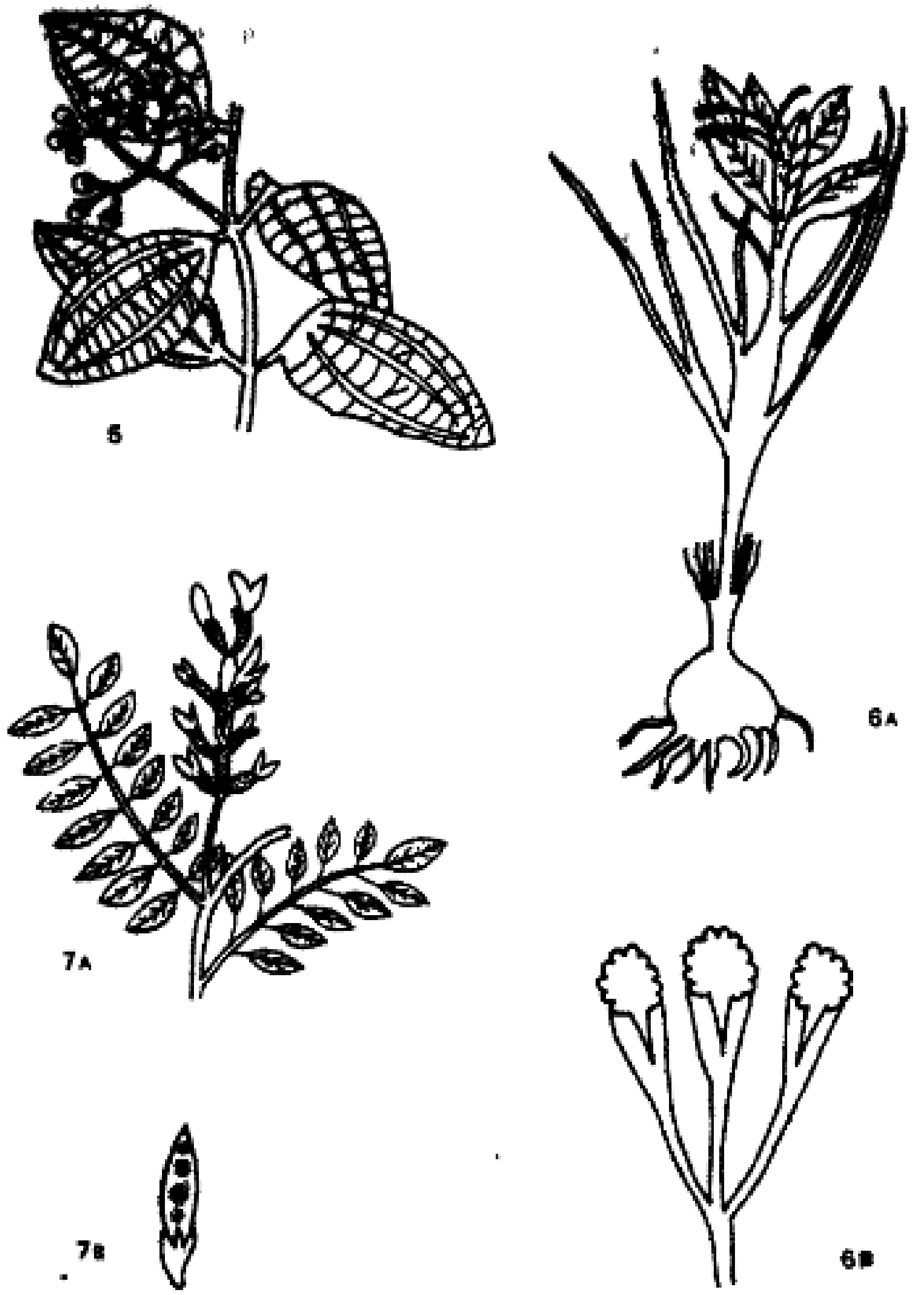


Fig. 5-7b. *Cinnamomum zeylanicum* (5), *Crocus sativous* (6a), *Stigma* with tip of the style (6b), *Glycyrrhiza glabra* (7a), a pod (7b)

During the 13th century there was an abundant supply of cinnamon, cassia, ginger, pepper, nutmeg and mace to all the European markets. The flavouring plants have practically no nutritive value, but some of them act as appetizers. Some of the flowering plants and their uses are described below.

***Aframomum.*** Seeds of *Aframomum melegueta* (family *Zingiberaceae*) are known as "Grain of paradise". The plant is native to West Africa. It is a perennial herb with fragrant leaves and aromatic seeds. They are used as condiments.

*Alpinia* (Hindi . *Barakaljan*, *Kulanjan*) · *Alpinia galanga* and *A. officinarum* are members of the family *Zingiberaceae* which are used for flavouring. The rhizome is often used as a substitute for ginger.

*Angelica* (Hindi . *Chora*, *Chura*) : *Angelica officinalis* or *A. archangelica* (family *Apiaceae*) are perennial herbs. All parts of the plant are aromatic and may be used for flavouring, but the broad, hollow stem is the part most generally used as a condiment. It is also used in cakes, pastries and sweets.

*Armoracia* : *Armoracia rusticana* (family *Brassicaceae*) are cultivated for their long, fleshy roots which are used as condiments. The plant is extremely pungent.

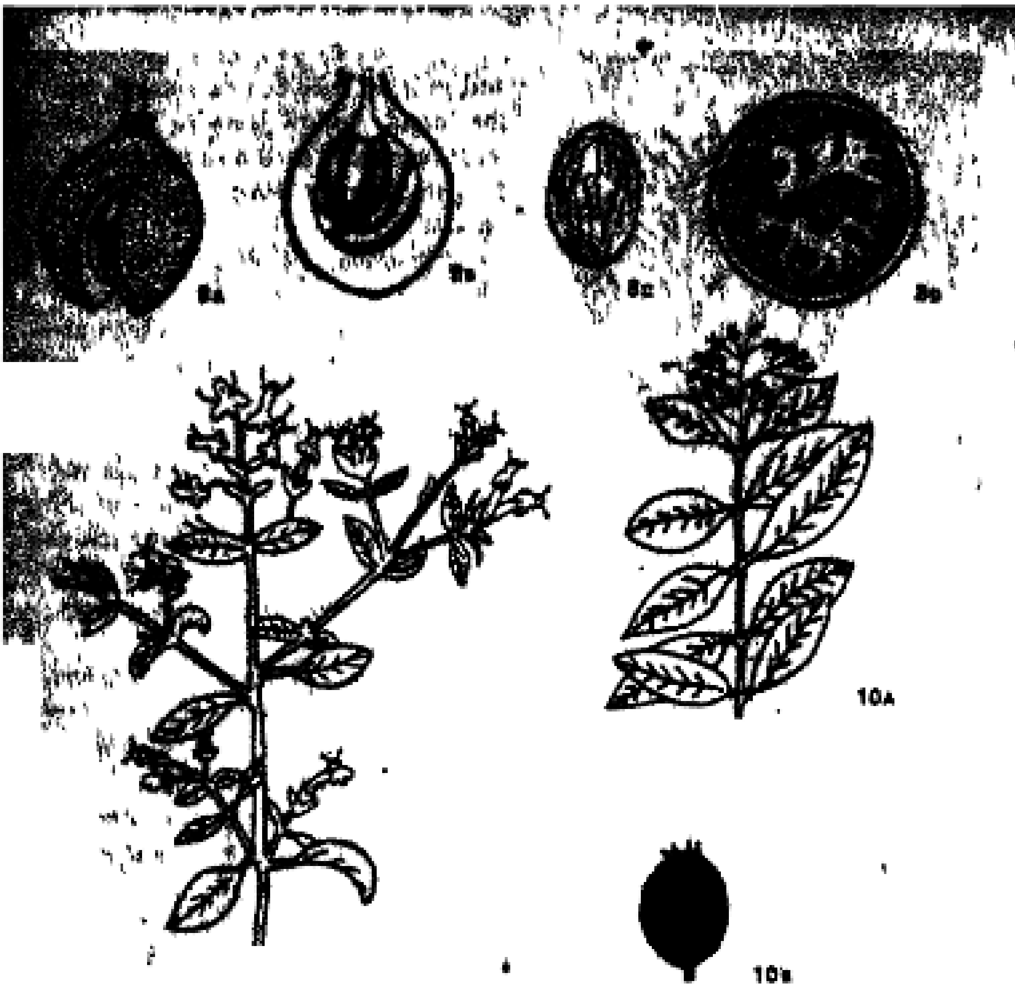
*Artemisia* (Hindi : *Nugdona*, *Gathivana*, *Majtari*) : *Artemisia vulgaris* are the perennial shrubs of the family *Asteraceae*. The young leaves and flowering tops are used as a spice to flavour roast geese, duck, pork, etc.

*Cinnamon* (Hindi : *Dalchini*, *Darchini*) · The export of *Cinnamomum zeylanicum* (family *Lauraceae*) is monopolized by Red China. Leaves of *C. tamala* are used as spices in preparation of curries in India. The *Cinnamon* bark is used for flavouring cakes, buns, etc. Stick cinnamon is used as an important ingredient in pickles, stewed fruits and in the preparation of beverages.

*Crocus* (Hindi : *Kesar*, *Zafran*): *Crocus sativus* (family *Iridaceae*) is commonly known as "Saffron". It is obtained from the stylar tips of flowers of *Crocus sativus*. It is cultivated in Europe, India and China. The name saffron originates from the Arabic *Zafaran*, meaning yellow. Saffron is often adulterated with flowers of *Carthamus tinctorius* (safflower), petals of *Caltha palustris* (marigold) and flowers of *Calendula officinalis*.

*Glycyrrhiza* (Hindi : *Mulhatti*, *Jethimadh*) : The roots of *Glycyrrhiza glabra* (family *Leguminoseae*) are used as a flavouring agent in confectionery and in the tobacco industry for improving the taste of tobacco. The exporter of this plant is Russia where it grows wild, mainly along the river Volga.

*Hibiscus* (Hindi : *Lalambari*) : *Hibiscus sabdariffa* var. *Sabdariffa* belongs to the family *Malvaceae*. These are small shrubs native to



**Figs. 8-10b.** *Myristica fragrans* (8a-d), Splitting berry (8a), Berry (8b), Nutmeg (8c), Nutmerg (8d), *Origanum vulgare* (9), *Pigmenta dioica* (10a), Berry (10b)

India but were introduced into Central America and West Indies. The fleshy succulent calyces are edible and used in flavouring various sauces or for the preparation of jellies.

*Laurus* (English : *Laurel*, *Avocado*) : *Laurus nobilis* (family *Lauraceae*) is a small tree of Asia Minor. Its dried leaves are added as spice to soups, sauces and meat dishes. From ancient times laurel leaves have been used as a symbol of victory and laurel wreaths were worn by victorious generals, emperors and also the winners at the Olympic games.

*Levisticum* : *Levisticum officinale* (family *Apiaceae*) are the perennial herbs. Their leaves and rhizomes are used as a culinary and spice.

*Majorana* (Hindi : *Murwa*) : *Majorana hortensis* are the perennial herbs of the family *Lamiaceae*. The fresh leaves are used as salads and the dried leaves and flowers are used as spice for flavouring sauces, meats and vegetables.

*Myristica* (Hindi : *Jaiphal*): *Myristica fragrans* (family *Myristicaceae*) are native to the Moluccas. The bright red 'aril' that develops from the funicle and micropyle surrounds the seed. The seed is called nutmeg. It is used as a spice in cakes, sauces, pickles and pastries.

*Origanum* (Hindi : *Sathra*, *Mirzan josh*). There are two distinct plants known as *Origanum*, one is *Origanum vulgare* belonging to the family *Lamiaceae* and other is *Lippia berlandii* of the family *Verbenaceae*. The dried leaves and flowering tops of these plants are used in Italian dishes (e.g., Pizzas).

*Penicillium*. Certain species of *Penicillium* are used in cheese processing, adding a special flavour to cheese. *P. camemberti*, *P. caseicolum*, *P. roquefortii* and *P. gorgonzolae* are used in the commercial production of cheese.

*Pimenta* (English : *Allspice*) ; *Pimenta dioica* is an evergreen tree of the family *Myrtaceae*. The plant is native to West Indies and Central America. Its flavour resembles a combination of the odour and taste of *cinnamon*, *nutmeg* and *cloves*. The ripe berries of *P. dioica* are used for flavouring a special drink based on rum.

*Petroselinum* (Hindi : *Sowa*, *Soya*) : *Petroselinum crispum* (family *Apiaceae*) is a known condiment. The pieces of fresh leaves are added to soups, stuffings, omelettes, etc.

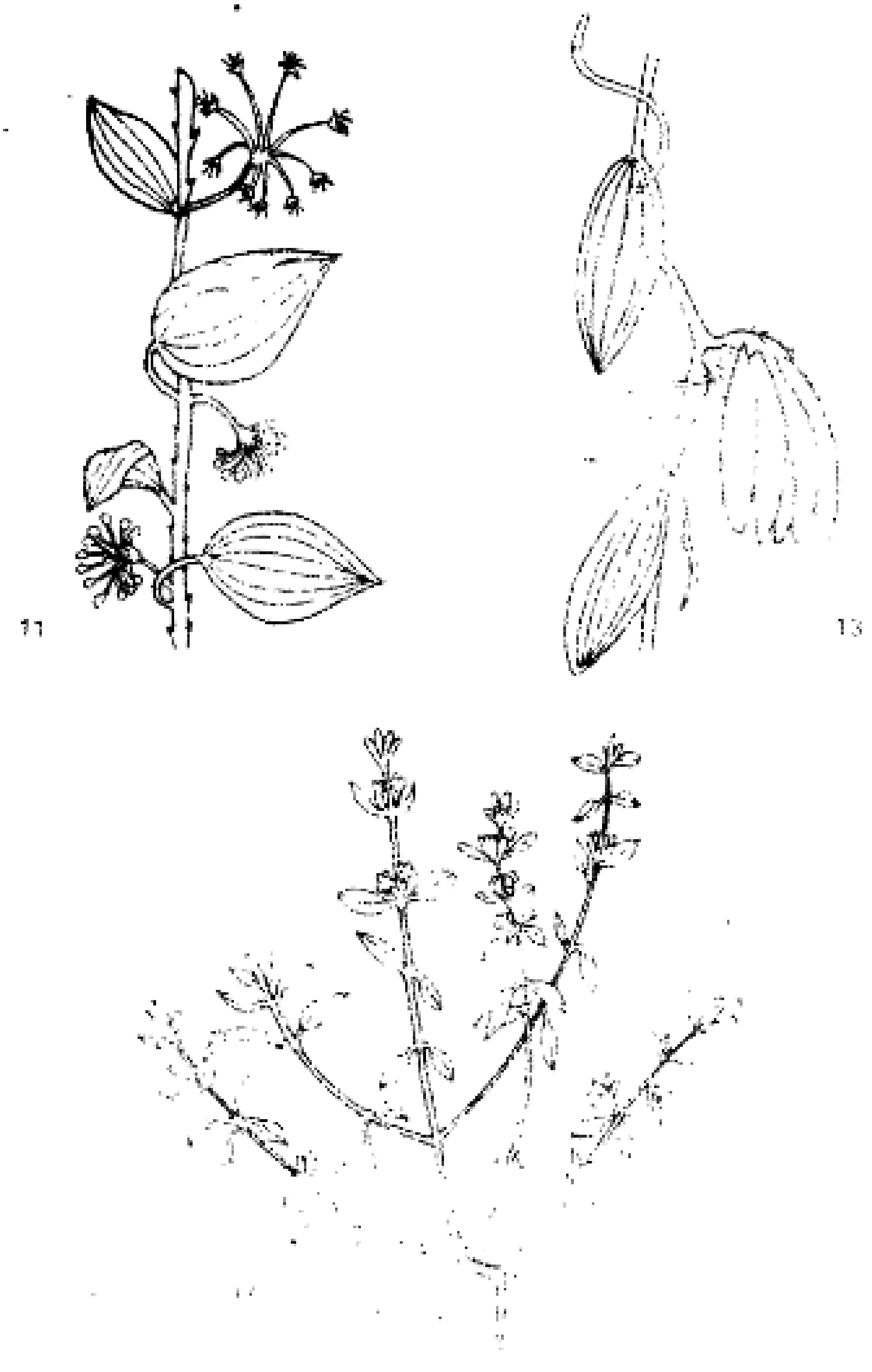
*Rosmarinus* (*Rosemary*) : *Rosmarinus officinalis* (family *Lamiaceae*) are the perennial evergreen shrubs. The leaves are used fresh or dried to flavour soups, sauces, meat dishes, vegetables and salads.

*Salvia* (Hindi : *Salbiasefakuss*) : *Salvia officinalis* (family *Lamiaceae*) are the shrubby plants. The dried or fresh leaves are used chiefly for stuffing poultry, meat, or sausages. Its essential oil is used for flavouring sausages, canned meat and liquors, while the young fresh leaves are normally used to flavour pickles, salads and cheeses.

*Smilax* (Hindi : *Chobchini*) : Dried roots of several tropical species of the genus *Smilax* constitute a flavouring material which is commonly known as "*Sarsaparilla*". In particular, *Sarsaparilla* is obtained from the roots of *Smilax aristolochiaefolia* of Mexico, *S. officinalis* of Honduras and *S. regelii* of Jamaica. It is chiefly used as a beverage condiment for the preparation of soft drinks.

*Thymus* (Hindi : *Ban ajwain*) ; *Thymus vulgaris* (family *Lamiaceae*) are the low shruby plants. Their leaves and flowering shoots are used as a spice for flavouring soups, gravies, sauces, poultry, stuffings, meats, sausages and liquors.

*Truffles* : Truffles are subterranean fungal fructifications [illegible]



**Figs. 11-13.** *Smilex officinalis* (11), *Thymus vulgaris* (12), *Vanilla planifolia* (13)

condiments. They form mycorrhiza in association with the roots of certain trees, chiefly Oaks. They remain in the soil about 10 cm to 0.5 cm beneath the surface and can only be located by specially trained dogs, or pigs which are able to distinguish them by smell. The smell of truffles may be discerned by trained animals at a distance of 110 m.

The best species of truffles, *Tuber melanosporum*, is found in France, Italy and Spain. The other edible truffles are *T. aestivum*, *T. nitidum* and *T. magnatum*. They are the most expensive edible plant materials.

*Vanilla* : *Vanilla planifolia* (family *Orchidaceae*) are the tropical climbing orchids of American origin. The useful part is the fruit, a pod-like capsule, which is harvested before it is ripe. The characteristic aroma of Vanilla develops during curing of the fruits. Vanilla is a condiment with multiple uses. Sugars and ice creams are flavoured with it. It is used in the production of cakes and sweet desserts.

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# Ramanujan's number

To commemorate the 93rd birth anniversary of the great Indian mathematician late Srinivas Ramanujan, here are presented some more pecularities of the famous number 1729, known as Ramanujan's number in the history of mathematics.

Ramanujan had expressed 1729 as the sum of the cubes of the two numbers in two different ways e.g.

$$\begin{aligned} 1729 &= 9^3 + 10^3 \\ &= 12^3 + 1^3 \end{aligned}$$

The divisors of the number 1729 are 1, 7, 13, 19, 91, 133 and 247 which are less than the number itself and many of them can be expressed as either the sum of difference of the cubes of the two numbers, e. g.

$$\begin{aligned} 7 &= 2^3 - 1^3 \\ 19 &= 3^3 - 2^3 \\ 91 &= 3^3 + 4^3 \\ 133 &= 2^3 + 5^3 \end{aligned}$$

The product of all of its divisors enumerated above gives the cube of the number itself, i.e.,

$$1 \times 7 \times 13 \times 19 \times 91 \times 133 \times 247 = (1729)^3$$

The sum of all of its divisors that are less than the number itself can be expressed as the difference of the cubes of two numbers as :

$$1 + 7 + 13 + 19 + 91 + 133 + 247 = 8^3 - 1^3$$

The sum of the digits of the number 1729 after casting out nines gives us the cube of number one.

The cube of the number 13, which is one of its divisors, is 2197, a number obtained by rearranging the digits of the number 1729.

If the number 1729 is subtracted from a number obtained by reversing the order of digits and if the result thus obtained is added to a number obtained by reversing the order of the digits of the result, we get the peculiar number 9999:

$$\begin{array}{rr} & 9271 \\ - & 1729 \\ \hline & 7542 \\ + & 2457 \\ \hline & 9999 \\ \hline \end{array}$$

Observe also the following equalities containing the numbers obtained by rearranging the digits of 1729, i.e., 1, 7, 2 and 9, e.g.

$$\begin{array}{ll} 1279 + 7912 & = 1972 + 7219 \\ 1792 & = 4^3 + 12^3 \\ 1297 & = 1^4 + 6^4 \\ 1927 & = 44^2 - 3^2 \\ 7921 & = 89^2 \end{array}$$

The number 1729 can also be expressed as the difference of two squares in four different ways :

$$\begin{array}{ll} 1729 & = 55^2 - 36^2 \\ & = 73^2 - 60^2 \\ & = 127^2 - 120^2 \\ & = 865^2 - 864^2 \end{array}$$

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# Science quiz

1. Opening and closing of stomata in plants is governed by :
   - (a) Potassium
   - (b) Sodium
   - (c) Boron
   - (d) Calcium
2. Which is the sweetest of all the sugars?
   - (a) Fructose
   - (b) Sucrose
   - (c) Glucose
   - (d) Lactose
3. Which of the following is used as a purgative?
   - (a) Corrosive sublimate
   - (b) Calomel
   - (c) Philosopher's wool
   - (d) Lithopone
4. Sodium thiosulfate (hypo) is used in photography
   - (a) To darken the image
   - (b) To dissolve unchanged silver halide
   - (c) To convert silver halide to silver
   - (d) To convert silver to silver thiosulphate
5. To test whether a given clear liquid is water, of the following methods the best one could be
   - (a) Smell the liquid
   - (b) Taste the liquid
   - (c) Add anhydrous cupric sulfate and look for a colour change
   - (d) Moisten litmus paper with the liquid
6. Anhydrous silica gel (indicating type) is blue in colour. It turns to pink with the adsorption of water because of the
   - (a) Presence of cobalt chloride
   - (b) Presence of cupric sulfate
   - (c) Presence of both
   - (d) None of these
7. Sodium chloride is a salt of
   - (a) Weak acid and weak base
   - (b) Weak acid and strong base
   - (c) Strong acid and strong base
   - (d) Strong acid and weak base
8. When $Fe^{+++}$ changes to $Fe^{++}$ in a reaction
   - (a) It looses a proton
   - (b) It gains an electron
   - (c) It looses an electron
   - (d) It gains a proton
9. Living organisms are mainly made of carbon compounds on account of
   - (a) Catenation
   - (b) Cementation
   - (c) Fermentation
   - (d) Isomerisation
10. A good criterion for the purity of an organic compound is
    - (a) White crystalline appearance
    - (b) Colourless and clear liquid appearance
    - (c) Sharp melting point/boiling point
    - (d) Odourless nature

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(ANSWERS on page 762)

# FOR HER

## Mother's milk versus cow's milk

BREAST feeding was the only source of human infant nutrition until the domestication of cattle which probably occurred around 5000 B C simultaneously in several geographical regions.

Three major problems have become evident from several recent studies on feeding of infants and young children.

(1) Prevailing maternal malnutrition results in secretion of suboptimal volumes of milk or in a premature diminution of secretion.

(2) The village diet which is generally based on cereals, legumes and tubers is the main source of maternal nutrition and weaning foods. The child must become adapted to village diets through a protracted and perilous weaning process which usually begins at 3-6 months of age.

(3) Infections, particularly those of the gastrointestinal tract, increase sharply with the beginning of weaning and become the main determinants of reduced food consumption, nutrition wastage and loss of body tissue mass.

It is likely that same problems afflicted ancient societies, probably forcing the utilization of non-human milk as a supplement to or a substitute for mother's milk.

Contemporary traditional societies are exposed to other complicating factors as well. Firstly the availability of great variety of artificial infant formulations and secondly the forces that push such societies towards a 'Western' way of life As a result, weaning takes place at birth or in the first month of life with the ensuing increases in diarrhoeal diseases, malnutrition and death.

Work done on human milk in recent years shows that breast feeding has nutritional, immunological, behavioral and economic benefits.

### Composition

Composition of human milk is such that the young infant can be successfully reared on this food alone for 3-4 months and for longer even, when supplements are added, provided enough of human milk is available

Cow's milk was thought as a substitute for human milk. But cow milk has been evolved to be suitable as food for the calf which should grow to adulthood within 2 3 years. Human progeny, on the other hand, does not reach maturity until in teens. So it is not surprising that the composition of cow's milk is much different from that of human milk (Table 1).

The amount of human milk ingested by nursing infant is about 600 ml per day. Although infants have been reared on cow's milk over periods unknown, differences in composition of two milks are such that to feed entirely on cow's milk may very well subject the human infant to some physiological stress This may or may not give rise to clinical symptoms in the long or short time Some anti-infection factors present in breast-milk are presented in Table 2.

It has been shown that exclusively breast-fed infants living in hot and humid climate are able to manage well without additional water, which may only be required during illness Because of the solute load in

**Table 1 : Composition of mature human and cow's whole milk**

| | *Concentration/100 ml* | *Human milk* | *Cow milk* |
|---|---|---|---|
| 1 | Total solids (g) | 11.3 | 12.6 |
| 2 | Fat (g) | 3.0 | 3.7 |
| 3 | Lactose (g) | 7.2 | 4.8 |
| 4 | Protein (g) | 0.9 | 3.4 |
| 5 | Whole protein nitrogen (mg) | 76.0 | 100.0 |
| 6. | Casein N (mg) | 41.0 | 43.0 |
| 7. | α-Lactoalbumin (mg) | 150.0 | 90.0 |
| 8. | β-Lactoglobulin (mg) | 0.0 | 300.0 |
| 9. | Serum albumin (mg) | 50.0 | 30.0 |
| 10. | Lactoferrin (mg) | 150.0 | 40.4 |
| 11 | Lysozyme (mg) | 50.0 | 0.01 |
| 12. | S. IgA (mg) | 100.0 | 3.0 |
| 13. | Retinol (μg) | 53.0 | 34.0 |
| 14. | Vit C (mg) | 4.3 | 1.8 |
| 15. | Vit A (μg) | 58.0 | 40.0 |
| 16. | Vit D (μg) | 0.01 | 0.06 |
| 17. | Potassium (mg) | 55.0 | 138.0 |
| 18. | Sodium (mg) | 15.0 | 158.0 |
| 19. | Calcium (mg) | 33.0 | 125.0 |
| 20. | Phosphorus (mg) | 15.0 | 96.0 |
| 21. | Energy (K. cal) | 67.0 | 66.0 |

**Table 2 : Antinfection factors of breast milk**

| *Factor* | *Function* |
|---|---|
| 1. Anti *Staphylococci* factor | Inhibits systemic *Staph*. infection |
| 2. S. IgA, IgM, IgG | Act against bacteria invading or colonizing mucosa |
| 3. Lactoferrin | Binds iron |
| 4. Lactoperoxidase | Kills *Streptococci* and *enteric* bacteria |
| 5. Complement ($C_4$, $C_3$) | Promote apsonization |
| 6. Lysozyme | Lyses bacteria |
| 7. Ribonuclease-like factor | Antiviral |
| 8. Bifidus factor | Stimulates growth of *Bifidobacterium* |
| 9. Lymphocyte | Synthetises S IgA |
| 10. Macrophage | Synthetises complement, Lf, Lysozyme and other factors |

cow's milk, infants fed on it require more water which increases the risk of enteric infections when the child lives under poor environmental conditions.

Due to low calcium level and low concentration of protein (particularly $\alpha_s$ casein components) human milk has a very low curd tension and when milk comes in contact with stomach fluid in an infant, it curdles due to interaction of chymosin and k-casein with calcium forming very soft coagulum. The difference in calcium/phosphorus ratio between human and cow's milks explains why tetany occurs much more commonly in the artificially fed new born. Moreover, due to high lactose content, besides serving energy requirements better, human milk also helps brain development of infants at an early stage. The two milks differ in vitamins content as well. Cow's milk is a richer source of B-vitamins but has less of A, C and E.

It has also been proved that β-lactoglobulin present in animal milk may be allergenic for infant, which seems to explain the higher morbidity due to asthma and other types of allergy in artificially fed infants. β-lactoglobulin is absent in human milk.

**Microbes**

Presence of lactic acid bacteria in human milk is significant in balancing the intestinal microflora of breast-fed infants. Lactic acid bacteria play an important role in human health. They have certain antibiotic activity against enteric pathogens. Certain antibiotic substances isolated from different types of lactic acid bacteria are diplococcin from cells of *Streptococcus cremoris* ($F_7$ and $F_8$ strains), Nicin from *S. lactis* which had a wider range than diplococcin and acidolin from *Lactobacillus acidophilus*.

Antibacterial activity of lactic acid bacteria is also due to decrease in pH because of formation of lactic acid, other organic acids, fatty acids and hydrogen peroxide.

It has recently been shown that *L. acidophilus* and *Bifidobacterium bifidum* dominate the genital organs of mother about to deliver. These bacteria enter into new born-baby through mouth and anus and are established in the intestine within 2 to 3 days. This speedy establishment is helped by components of mother's milk (certain oligosaccharides also called *Bifidus* factor constituted of D-glucose, D-galactose, N-acetyl D-glucosamine and L-fucose with lactose at reducing end) which enhances multiplication of the bacteria and action of immunoglobulins, bile acids, environmental factors such as pH redoxpotential, etc., in the intestine. As a result *Escherichia coli*, intestinal cocci, non-sporeforming gram positive anaerobic bacteria, which are known to be a part of intestinal microflora of normal healthy child, are not able to reach the jejunum of the new-born infant.

It has also been shown that in parts of small intestine where peristaltic movements are slow, there are a large number of non-sporulating anaerobic bacteria such as *Bacteroides*, *B. bifidum*, etc.

The earlier mentioned *Bifidus* factor is characteristic of human milk and due to this *Bifidobacterium bifidum* is naturally present in greater number in babies fed with breast milk. Babies fed on bottle milk have *L. acidophilus* as the predominating microorganism. The predominant *Bifidobacteria* may play a contributory role in the low frequency of *Shigella* and other enteropathogens during breast feeding and due to this host-favourable bacterial interaction breast-fed babies are more resistant to intestinal infections and have lower morbidity and mortality than bottle fed babies. Bottle fed babies usually develop the adult type of intestinal microflora pattern, earlier than breast fed infants and as *B. bifidum* is less in bottle fed babies so *L. acidophilus* prevents multiplication of pathogenic organisms in intestine. However, while *B. bifidum* has a strong symbiotic relationship with the host, that of *L. acidophilus* is weaker and it has the character of a temporary inhabitant of the intestine. Therefore, for proper protection of the host the number of *L. acidophilus* cells in intestine becomes important.

Because of lower incidence of *B. bifidum* in intestines of bottle fed babies gram – ve bacteria such as *Bact.*

(*Continued on page 768*)

# Science in Industry

## Utilisation of bagasse

SUGARCANE bagasse, an agricultural waste, is a chief source of cellulose. Almost all the bagasse is burnt away by the producing units themselves as a cheap fuel. Since protein deficiency is probably the most serious and a fast-growing problem, particularly in developing countries, the use of some portion of bagasse for the production of single-cell protein will not appreciably reduce the fuel value of it. For a better economy, it is an essential step to get some by products like protein from waste materials, which will not only solve the problem of protein deficiency but also the waste disposal and environmental pollution problem. Studies on the utilization of bagasse for single-cell protein will also help in evaluating alternative lignocellulosic substances such as city refuse, cow dung and agricultural wastes for the above purpose. Single-cell protein can be produced from cellulosic wastes either by growing microorganisms, like yeast, on the sugar produced from the hydrolysis of cellulosic or hemicellulosic portion by acid or enzyme, or by directly growing microorganisms on cellulose, rich in protein. Shri S.R. Joshi of the Bacteriology Cell of the National Environmental Engineering Research Institute (NEERI), Nagpur, has studied all these methods of utilizing sugarcane bagasse.

Experiments to saccharify the cellulosic and hemicellulosic portion of bagasse with different concentrations of sulphuric acid at different solid-liquid ratios and at different temperatures revealed that a maximum saccharification of 30-35% of bagasse could be achieved at autoclaving temperature, with a bagasse concentration of 4-6% and sulphuric acid of 0.8 %

To saccharify the cellulosic portion of bagasse by cellulase enzyme, different soil samples were screened for highly cellulolytic microorganisms. Different cultures of *Trichoderma*, including the mutants, were also tested for cellulase enzyme production using bagasse as substrate. *Trichoderma viride* QM 9414, a mutant,, was the most efficient amongst the cultures tested for cellulase enzyme production.

Studies on nutritional requirement of this culture for the maximum production of cellulase revealed that alkali-treated bagasse (0.5%), ammonium sulphate (0.15%) and urea (0.03%) as nitrogen source, Tween 80 (0.1%), magnesium sulphate and calcium chloride (0.03% each), and proteose peptone (0.07%) in Reese medium produced maximum cellulase enzyme at 5 to 7 days' incubation period on a rotary shaker.

To make the bagasse more amenable for enzymatic attack, it was pretreated with different concentrations of alkali (sodium hydroxide) at different temperatures to remove the lignin and to swell the cellulose. It was observed that 2% alkali treatment to 5% bagasse at 121°C for 15 minutes was the most efficient one.

Experiments were carried out to saccharify the pretreated bagasse with cellulase enzyme obtained from *T. viride* 9414 culture. At lower concentrations of substrate (bagasse) there was more saccharification (70-80%) but was less at higher concentrations. The optimum temperature for the reaction was 50 C. Maximum saccharification was achieved in 48-hour incubation period.

In order to find out the utilization of sugars present in hydrolysate obtained after acid hydrolysis and enzymatic saccharification of bagasse, *Candida tropicalis*, a yeast, was grown as the source of single-cell protein It was observed that the sugars formed in the hydrolysate were utilized by the yeast. There was no inhibitory effect of other soluble materials present in the acid hydrolysate of bagasse on the growth of the yeast.

As a source of single-cell protein, *T. viride*, a highly cellulolytic culture isolated in this laboratory, was grown on alkali-treated bagasse in a simple aeration unit using Reese medium When the *p*H of the medium was maintained at 4.5-5.0, 70% of bagasse added was converted into biomass in 48 hours. Estimation of residual or unutilized bagasse in biomass revealed that it was more when bagasse treated with alkali at room temperature was used in the medium and was less when it was treated with alkali at 121°C for 15 minutes.

# TECHNOLOGY FOR VILLAGES

## Rural industries

RURAL industries are characterised by their suitability for installation and operation in villages. They are usually cottage scale or small scale requiring limited capital and energy and could be worked with technical skills locally available. Such industries usually utilise one or the other raw material available in the area and have a direct impact on employment generation and improvement in the economic condition of the local population. CSIR laboratories have developed many technologies based on raw materials from agriculture, forest, and animal sources which are helpful in promoting rural industries.

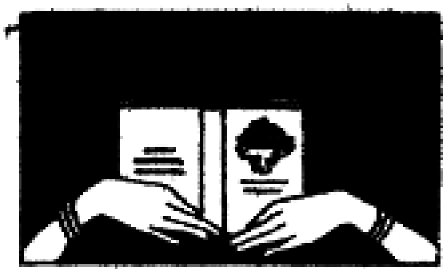
**Foods and beverages**

*Cereals and products*: Central Food Technological Research Institute, Mysore has technologies for improved processing of paddy, maize and *dhal* which give higher yield of better finished products. It has designed mini ricemill, mini maize-mill and pulse milling units which could be set up in rural areas. The designs of mini ricemill and mini maize-mill have been released The Institute has developed improved methods for curing and parboiling of paddy and equipment for stabilisation of rice bran. CFTRI has also developed processes for manufacture of variety of food products—(i) Bran free flour and suji from jowar, (ii) energy foods from wheat, bengal gram and groundnut flour, (iii) instant mixes for idli, dosa, vadai, jilebi, gulab jamun, (iv) ready mixes for sambhar and rasam, (v) papads from pulses (vi) macroni type products from flour and tapioca, (vii) weaning foods from bengal gram, dhal, green gram etc., (viii) protein enriched wheat flour, and (xi) starch and sago from tapioca etc.

*Fruits and vegetables*: Fruits and vegetables are perishables and CFTRI has perfected techniques for their preservation as such or in the processed form. Processes for canned, bottled and dehydrated fruits and vegetables are available. It has designed equipment for drying of cashewnuts, walnuts and arecanut. Regional Research Laboratory, Jammu, has knowhow for dehydration of apricots. The process for vacuum puff-drying of vegetables (CFTRI) has also been developed. The technology for cultivation and processing of edible mushrooms has been developed at CFTRI, RRL, Jammu and National Botanical Research Institute,Lucknow. RRL Jammu and NBRI are distributing mushroom spawns in rural areas for mass cultivation CFTRI has a process for dehydration and drying of mushrooms. CSIR laboratories have developed processes for a variety of fruit and vegetable products—apple juice, processed cherry, and cider and wine from apple (RRL, Jm.), papain from papaya, fruit juice concentrates, fruit bars, fruited cereal flakes, fruit juice powder, liquid fruits, banana chips, potato chips, dessicated coconuts, pectin and essence from citrus fruits, tomato juice concentrate and pickles (CFTRI) and raisins from grapes (NBRI). CFTRI is working on the manufacture of cashew butter and development of Indian sweetmeats partially or wholly based on fruits and vegetables. CFTRI is having a project on fermented beverages and concentrates for soft drinks. These processes such as malt from ragi and honey-based beverages could be utilised in rural areas. The Institute developed technique for monsooning of coffee.

*Spices*: Spices are favoured articles of food, valued for their flavour and colour. CFTRI has developed improved processes for drying of red chillies and ginger and curing and polishing of turmeric. It has evolved techniques for retention of green colour in cardamom pods and production of dried green and buff coloured white pepper. The technologies for manufacture of spice oleoresins, cardamom oil, garlic powder, tamarind juice concentrate and buff coloured dried pepper have been commercially exploited. These products have good export potential. The Institute also has know-how for manufacture of quality spice and curry powders. Central Institute of Medicinal & Aromatic Plants, Lucknow has also developed know-how for manufacture of oleoresins from ginger and capsicum.

Salt is another necessary ingredient of food. Central Salt and Marine Chemicals Research Institute, Bhavnagar, has complete technology for manufacture of table salt, refined salt, salt fortified with minerals as also cattle lick salt. The Institute has so far helped in the establishment or improvement, of nearly 18 small salt works situated in rural coastal area. The process for manufacture of iodised salt has been commercially utilised. The technology for manufacture of agar-agar from red seaweed is in production. The knowhow for alginic acid and sodium alginate has been released to industry.



## BOOK REVIEWS

**MESSAGES FROM THE STARS** by Ian Ridpath, *Fontana Books*, (Available from *Macmillan India*, 2/10, Ansari Road, Daryaganj, New Delhi-110002) Pp 224, Rs. 19.50.

"ARE we alone in the universe?" This is perhaps one of the most hotly debated, yet unsolved, questions that has vexed the mind of man for ages. There have been myths, sensational accounts of visitations by extraterrestrial beings, and exciting stories of UFO landings and ancient astronauts. In *Messages from the Stars*, author Ian Ridpath takes a critical look at these accounts and attempts to explain the various possibilities of extraterrestrial life on a strictly scientific basis.

He begins by looking at the possible reasons for the belief in life elsewhere in space and at the attempts by scientists to detect such life. For instance, the Viking missions in search of life on Mars, or the search for radio signals from any advanced civilisation in space. So far, all these attempts have been unsuccessful, but, the author notes, "the scientific search for extraterrestrial life has become a boom subject". The reader will easily find out why this is so. For one thing, strictly on a probabilistic basis, life ought to be abundant throughout space. May be, they are too far distant so that it takes a long time for their signals to reach us. Or, may be, life elsewhere is entirely different from the one we know on earth. As of now, we do not know the reality.

The book also discusses at length the possibilities of human colonisation of space, in giant space structures, besides the prospects of travel to the stars and the consequences of such action. In the last three chapters, Ridpath takes on writers such as Erich von Daniken and others who make fantastic claims about visitations by extraterrestrial 'Gods'. He critically examines the claims in the light of established scientific facts and the results of the systematic search for extraterrestrial life, and concludes that they are nothing but "self-confessed adventure stories in the guise of speculative fact". His arguments are sound and convincing.

Overall, the book makes exciting reading and is highly informative. It should help in dispelling many a misconception from the mind of the reader and make him take a more rational view of the universe around us.

BIMAN BASU

**LABORATORY MANUAL IN MOLECULAR GENETICS** *by* Kunthala Jayaraman and R Jayaraman, *Wiley Eastern Ltd.*, 4835/24, Ansari Road, New Delhi-110002, 1980, Pp. viii+40, Rs. 10.00

THE book under review deals with laboratory techniques in understanding molecular mechanisms in bacterial and viral genetics. The manual is divided into six units. Unit I deals with sterilisation techniques, isolation, purification and maintenance of bacteria and quantitative measurement of bacterial populations. In simple and lucid language, the authors have in the subsequent units described the bacterial growth curve, mutations induced by physical and chemical agents such as UV radiation and N-methyl N'-nitro N-nitroso guanidine and isolation of auxotrophic mutants from *E coli*. Other experiments included in the book concern bacterial conjugation and identification and characterisation of donor and recipient strains of bacteria.

In Units 3 and 4 are presented some experiments using bacteriophage T4—building of phage stock, kinetics of phage growth, transfer of bacterial DNA from one cell to another by the phage (transduction) and incorporation of the phage genome into bacterial chromosome (lysogeny).

In 1961, Jacob and Monod, in an elegant experiment, elucidated the phenomenon of enzyme induction and repression and postulated the operon concept. The last Unit describes a model experiment for the induction of B-galactosidase activity in *E. coli* using O-Nitrophenyl-B-D-galactopyranoside as substrate.

The experimental protocols are well presented and concise. Recipes for the preparation of various media and sources for obtaining different strains of bacteria and bacteriophages are included in the Appendices. The manual will serve as a helpful aid in designing simple experiments to demonstrate genes and their actions in bacterial and viral systems.

DINAKAR N

**FRESH WATER ANIMALS OF INDIA—AN ECOLOGICAL APPROACH** *by* G.T. Tonapi, *Oxford & IBH Publishing Co.* 66, Janpath, New Delhi-110001, Pages XVIII + 341, Rs. 19.50, 1980

THIS book is certainly a new approach to the study of fresh water animals with particular reference to Indian species. The author, G.T. Tonapi, Head, Department of Zoology, University of Pune, being a quite experienced person in the field, has given the material in a coherent manner starting with the historical development, biotic features of the aquatic environment, emphasis on the habitats and adaptations for locomotion and planktonic habits. Then the different phyla have been discussed providing sufficient details about the different forms. Different chapters have also been given weightage according to their economic values. For example, Arthropoda, Insecta, Mollusca, Pisces, have been allotted much larger space than those groups which are of comparatively less importance.

In the various phyla the description also is adequate which will certainly satisfy the requirements of any reader. However, if some body wants an exhaustive account of any particular form, this book is not for him. The most important aspect of the book is the prospects and problems section at the end of each phylum, which gives, although briefly, the possibilities of further research in the field. Although the number of photographs are few, the large numbers of drawings have certainly filled the gap. In fact, one cannot underestimate the values of the drawings which are very neat and clear.

There are also certain drawbacks with the book. In the first place, the author has not given adequate weightage to the recent literature eavailable. Most of the references are old and there are only a few from the seventies. Even those which are present are the contributions of the author. It seems that the gap between preparation of manuscript and its actual publication was too long. The chapter 26 dealing with economics of fresh water could have been more exhaustive. Besides, there are certain conceptual errors. For example, on page 312 at the end of para 2 it is mentioned "In any case, polluted or sewage water gets purified if allowed to flow for four or five miles". It is a generalisation which would rarely be true except if the pollutants are some simple organic molecules. The flow of language is also not as good as is normally expected from an author of the stature of Dr. Tonapi. Typographical mistakes are also too many.

ASRARUL HAQUE

**LABORATORY EXPERIMENTS IN DIGITAL SYSTEMS** *by* Himanshu B. Dave. *The Macmillan Company of India Limited,* 1977, Pp. 201, Rs. 35.00.

THE use of digital techniques for various signal processing applications has increased tremendously in the last few years and this trend is expected to continue in the years ahead. In this regard the book under review covers all important aspects of digital communication. The context and the organization of the book is aimed at elucidating the basic concepts in digital systems through experimentation using inexpensive and modern integrated circuits.

The first chapter covers the basic logic functions and their notations including the truth tables. The chapter 2 deals with combination circuits employing basic logic functions. Chapter 3 discusses various circuits with memory. Chapters 4 and 5 deal with logic circuits for computers. Chapter 6 covers various interfacing circuits like CRT character display, graphic display, A/D and D/A converters, etc. Chapter 7 includes some possible laboratory projects which can be taken up by the students. These include IC tester, electronic clock, electronic jackets, etc.

The problems included with each chapter will be useful for the students in getting in-depth knowledge of the fundamentals. The author has treated the subject matter rigorously to make it suitable as a text book. It is also useful for practising engineers.

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**Books Received**

1. **AGRAJA BIJNANI** *by* Samarjit Kar, *Ananda Publishers Pvt. Ltd.*, Calcutta-700009, Pp. 160, Rs 15.00.
2. **A HANDBOOK OF SI UNITS** *by* M. A. Venkatachar, *Sultan Chand & Sons*, 4792/23, Daryaganj, New Delhi-110002, Pp. 72, Rs. 7.50.
3. **FUNDAMENTALS OF MODERN PHYSICS** *by* B D Duggal and C. L. Chhabra *Vishal Publications*, 6, U.B. Bungalow Road, Delhi-110007, Pp. 448, Rs. 25.00.
4. **CHEMISTRY FOR CLASS XII** *by* N. R. Banerji, S. K. Vig, and R. K. Trikha, *Tata McGraw-Hill Publishing Co. Ltd.* 12/4, Asaf Ali Road, New Delhi-110002, Pp. 615, Rs. 21.50.
5. **OUTLINES OF CHEMISTRY FOR CLASS XII,** *by* M. Katyal and R. P. Katyal, *Tata McGraw-Hill Publishing Co. Ltd.*, (address as above) Pp. 412, Rs. 14.50.
6. **TEXTBOOK OF BIOLOGY FOR CLASS XII** *by* M. S. Sankaran and K. R. Sharma, *Tata McGraw-Hill Publishing Co. Ltd.*, Pp. 629, Rs. 22.00.
7. **ENERGY SYSTEMS AND DEVELOPMENT** *by* Jyoti K. Parikh, *Oxford University Press*, 2/11, Ansari Road, Daryaganj, New Delhi-110002, Pp 152, Rs. 75.00.

# FROM THE INFINITE

Distant Galactic System

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